PLANT BREEDERS' RIGHTS:

SOME ECONOMIC CONSIDERATIONS

A Preliminary Report

ECONOMIC WORKING PAPERS

DOCUMENTS DE TRAVAIL ÉCONOMIQUES

Agriculture Canada

March 19, 1984

PLANT BREEDERS' RIGHTS:

SOME ECONOMIC CONSIDERATIONS

A Preliminary Report

Pamela Cooper

This study was done in response to a request by Senior Management Committee to the Seed Division. This report was written by P. Cooper, an economist in the Marketing and Economics Branch. Valuable discussions with Mr. W.T. Bradnock, Director of the Seed Division were extremely helpful, particularly at the early stages of the study. V. Sisson of the Seed Division was also extremely helpful, providing data, clarifications and comments on earlier drafts of the report. The comments of several reviewers are also greatly appreciated.

This report is distributed as a working paper for discussion and comment. The findings and views expressed do not necessarily represent those of Agriculture Canada.

TABLE OF CONTENTS

	Page
Executive Summary	iv
INTRODUCTION	1
I. CURRENT STRUCTURE OF THE SEED INDUSTRY	5
Plant Breeding	5
Multiplication of Seed	9
Seed Processing	13
Seed Distribution: Wholesaling and Retailing	13
Seed Firms: Acquisitions and Diversification	15
Table A. Seed Industry Acquisitions 1975-1982	17
Seed Distribution: Contract Seed Production and SeCan	19
Size and Overview of the Seed Industry	22
Table B. Percentage of Prairie Acreage of Major Crops Seeded with Pedigree Seed, 1980	25
Footnotes	29
II. PROPOSED PLANT BREEDERS' RIGHTS LEGISLATION	34
Footnotes	39
III. PLANT BREEDERS' RIGHT AS AN INTELLECTUAL PROPERTY RIGHT	40
A Separate System of Reward	40
The Goals and Objectives of Intellectual Property Law	41
The Benefits of a Patent System	44
The Costs of a Patent System	48
Optimal Patent Design	51
Footnotes	58

Page

IV. PLANT BREEDING RESEARCH 66

The Current State of Plant Breeding Research in Canada .. 67

Table C. Plant Breeding Research in Canada for Major Crops 69

Table D. Origin of Cereal, Grain and Oilseed Varieties Licensed in Canada 72

Table E. Origin of Selected Forage, Grass and Other Crop Varieties Licensed in Canada 73

Variety Protection and Breeding Research in Other Countries 76

Breeding Costs in Other Countries 81

Rate of Return to Breeding Research and Beneficiaries of Agricultural Research 83

Footnotes 87

V. RESEARCH AND DEVELOPMENT AND THE FIRM: ALTERNATIVE INCENTIVES AND FACTORS INFLUENCING THE RESEARCH DECISION .. 94

Alternative Incentives for Research and Development 94

Research in the Private Sector 95

Research in the Public Sector 97

Characteristics of the Firm and Industry Affecting Research Performance 98

Size of Firm 99

Ownership of the Firm 100

Industry Market Structure and Research Performance 106

Summary 109

Footnotes 111

Page

VI. CONCLUSIONS 116

A. Flexible Application of the Proposed Legislation 117

B. Relationship between the Seeds Act and the Plant Breeders' Rights Bill 119

C. The Use and Composition of Advisory Committees 120

D. Review of the Legislation 122

E. Seed Prices, Royalties, Research and Advertising 125

F. The Impact of Plant Breeders' Rights on Large and Small Breeders 129

G. The Impact of Plant Breeders' Rights on Domestic and Foreign Breeders and on the Location of Research 131

Footnotes 134

Annex A - The Industrial Economics of Advertising 139

Annex B - Compulsory Licensing and the Pharmaceutical Industry . 141

Executive Summary

The study identifies the major economic considerations and potential effects of plant breeders' rights legislation in Canada for the seed industry and for Canadian farmers.

The seed industry is extremely complex and diverse. Farmers may use their own seed or may purchase seed from another farmer. The commercial market for seed includes both common seed which cannot be classified by variety name and pedigree seed which is always sold by variety name. Plant breeders' rights legislation would affect only pedigree seed sold by variety. The choice by farmers of whether or not to use purchased seed, and if so, of what standard or quality depends on a number of factors including habit and tradition, the manner of reproduction for the species (self-pollinated, cross-pollinated or hybrid) and on relative costs and potential yields.

The seed industry is really many different industries, divided both by sector (breeding, multiplication, retailing, etc.) and by crop (corn, forages, field seeds, etc.) so that overall generalizations are impossible. Firms may be active in one or more sectors and in one or more crops. The major sectors of the seed industry are breeding research, testing, multiplication, processing and treatment, distribution and retailing. The major institutional features of the seed industry include the Seeds Act, variety licensing, contract production and SeCan, an association for the promotion and distribution of public varieties.

New varieties are continually needed to improve yields and to replace older varieties whose resistance to disease and pests has diminished over time. New varieties are obtained from public research programs, from imports of public and privately developed varieties and from private breeding programs.

The Plant Breeders' Rights Bill (Bill C-32) was initially introduced in May 1980. The objectives of the Bill are to:

1) grant legal recognition, similar to a patent, that a new variety is the property of the breeder;

2) provide a legal means by which royalties may be collected on varieties in Canada;

3) stimulate further plant breeding in Canada;

4) facilitate royalty collection on Canadian varieties used abroad; and

5) facilitate the importation and distribution of protected foreign varieties for use in Canada.

The breeders' right is very similar in effect to a patent. It gives the breeder exclusive rights to multiply and sell his variety, or licence others to do so, for a period of up to 18 years. Under the Bill breeders may be given either partial or completely exclusive rights or they may be subject to automatic or compulsory licences if others wish to multiply and market the variety.

The proposed breeders' rights legislation is analyzed in a comparison with the existing patent system, since the effects of the patent system can provide some insight into the effects of the proposed legislation. There are indications that the breeders' rights legislation will have a positive impact on breeding research since a patent-like system provides the greatest stimulus to innovation where it is not otherwise possible to appropriate the returns of unprotected innovation, for example where the advantages of being first on the market are small or where widespread and rapid imitation is easy. Although it is often the small breeder or inventor who can benefit from a patent or breeders' rights system since it provides protection for his work, the costs of the system may also be proportionately more burdensome for the small breeder. In addition, small breeders may require some financial assistance to maintain a breeding program until royalties and seed sales can support the research.

There are costs, both direct administrative costs and indirect costs in terms of higher prices and lower outputs, associated with intellectual property rights. However, the indirect costs of a patent system may be minimized by features such as limiting the term of the right, fee structure, and using compulsory licensing. Many of these features have been built-in to the breeders' rights system and will enable adjustments to be made to the trade-off between the incentive effect of the legislation and the potential monopoly costs associated with it.

The major goal of breeders' rights legislation is to stimulate additional plant breeding research in Canada. The current state of plant breeding research in Canada and the possible areas of further breeding work with rights legislation are considered. The factors affecting the degree of incentive for private research are extremely

complex. Breeding will be encouraged for those crops whose seed farmers tend to purchase each year and for crops whose acreage is large and/or increasing rapidly. Smaller, more localized crops would continue to be likely candidates for imported varieties, while crops with strict quality controls and grading requirements such as bread wheat and malting barley would continue to be bred by the public sector because of more demanding breeding requirements. In addition, local or special-purpose varieties are likely to continue to be bred by the public sector since the size of the potential market may not make it profitable for private breeders. The returns to breeding research and results of variety protection in other countries are also considered. The returns to agricultural research are high and indicate a relative under-investment in plant breeding from society's point of view. Social returns to plant breeding are high, with benefits being distributed between producers and consumers. High social rates of return indicate a need for further investment in plant breeding, in the public and private sector.

The legislation is designed to stimulate breeding research, and it is clear that there is a significant role for both public and private work within plant breeders' rights. Public plant breeding has successfully played the major role in developing new plant varieties for Canadian agriculture and this is expected to continue since the Department is committed to breeding research and variety development. Private breeding will complement, but not substitute for public breeding. Private breeding will also be affected by other programs and policies of the government that are designed to encourage private investment in research. The size and ownership of the firm as well as industry concentration affects the amount of research performed by private firms.

Examination of available information indicates that royalties are not likely to affect the price of seed significantly. Royalties have been estimated to increase the price of Certified seed by 5 - 10%, but actual price increases are limited by the elasticity of demand for seed. It is hypothesized that, since farmers have alternatives to the purchase of pedigreed seed for most crops, the demand for pedigreed seed is fairly price-elastic. Data adequate to test this hypothesis are not currently available. Evidence indicates also that there is relatively little danger that the plant breeders' rights legislation, in itself, will encourage multi-national acquisitions in the Canadian seed industry.

In summary, the purpose of this study was to consider the possible effects of breeders' rights legislation in Canada and to lay a basis for evaluation of the legislation's effects. Quantitative consideration of the probable effect of breeders' rights was greatly restricted by the lack of data and by the limited hard documentation of other countries' experience with similar legislation. One of the major goals of the study was to identify areas where better data collection is needed such as in the trade and pricing of seedstocks, especially the quantities of pedigreed seed used. The study also provides a baseline picture of the structure of the seed industry to assist evaluation of the legislation once it is in place.

March 9, 1984

PLANT BREEDERS' RIGHTS: SOME ECONOMIC CONSIDERATIONS

INTRODUCTION

In this paper the implications to producers and consumers of plant breeders' rights are examined. The paper proceeded with several general objectives in mind. The first objective was to review and consider the arguments used for and against Plant Breeders' Rights legislation. Secondly, the potential for monopoly power in the seed industry was assessed, identifying implications for any group which might be affected. The potential costs and negative implications of the legislation were compared with expected benefits.

A search of the literature on plant breeders' rights produced very little solid material providing hard evidence on the effects of this legislation, so that economic theory was examined to indicate what the effects might be.

Thus, the issue is considered by focusing on the potential impact of Plant Breeders' Rights legislation on the structure and performance of the seed industry. The introduction of this legislation is the clearest and most recent step in the process of increasing private control over seed breeding, production and distribution in Canada, continuing a trend which started several decades ago. Privatization in the seed industry can mean many things.

It includes the release of public varieties to private control through SeCan, an association for the multiplication, promotion and distribution of federal and university varieties, the release of some university varieties on an exclusive basis to seed companies, and the increased interest of private seed companies in developing their own seed breeding programs.

The Plant Breeders' Rights legislation will extend this process by providing the breeder of a new variety with exclusive rights over the multiplication and sale of that variety. The right operates similarly to a patent right in that others may be charged a royalty if they wish to multiply or sell the variety.

The study starts by examining the structure of the seed industry. The seed industry, which is described in detail in an unpublished background paper, is not one industry, but is many different industries. There are substantial differences in the structure of both levels (breeding, multiplication, processing and distribution) and sectors (grains and oilseeds, forage and cereal crops, legumes, vegetables, fruits and ornamentals) within the seed industry. Moreover, there are also significant technical factors, such as whether a crop is a hybrid, cross-pollinated, or self-pollinated, and institutional factors, such as the Seeds Act, that have affected the existing structure and behaviour of each sector and are likely to affect the potential impact of Plant Breeders' Rights on specific crops. The heterogenous nature of the seed industry and the factors and institutions influencing it, which make analysis difficult, might also be used to identify a range of potential outcomes. Unfortunately, hard information and data on many aspects of the seed industry are either non-existent or sketchy, poor and inconsistent. These factors limit the empirical analysis of the likely impact of Plant Breeders' Rights on the structure, conduct and performance of the seed industry.

The second section of the paper describes the plant breeders' rights system proposed, while the third section compares it with the existing patent system. Although it is impossible to predict accurately the detailed effects of Plant Breeders' Rights on the structure and performance of the seed industry in Canada, some assistance in anticipating general results comes from a number of sources. The economic theory of patents provides a useful guide for a comparison between the status quo and the market result after a limited monopoly right has been granted to the breeder of a new variety. Since the system proposed is very similar to a patent system, economic analyses of the patent system can give an indication of what might happen in different circumstances. For example, the existence of a competitive or non-competitive market before the introduction of breeders' rights may change the final outcome under this legislation. The usefulness of this comparison may be limited, however, since the patent system is an established one, and a comparison of industries before and after the introduction of the system is not possible. Some comparisons can be made between industries that use patent protection and those that do not (by preference or by ineligibility), if inter-industry differences other than those attributable to the patent system are minimal or can be taken into account. Finally, the experience of other countries with the introduction of a system of variety protection or breeders' rights can be helpful. However, it is expected that factors such as industry structure before the introduction of variety protection, the previous level of publicly funded research, and the pre-rights degree of development in the private sector would affect both the results of variety protection in other countries, and the relevance of their experience for Canada.

The study considers the impact of introducing a legal intellectual property right, formalizing and replacing the contractual arrangements currently used to maintain a breeder's control over his variety.

Intellectual and industrial property is the term used to refer to the forms of intangible property rights protected by patents, copyrights, trademarks, and industrial designs. Particular attention is paid to the significant role played by the public sector in plant breeding, variety licensing and other aspects of seed distribution. The efficacy of the proposed legislation in achieving its goals will also be considered. The study is limited primarily to selected economic aspects of the legislation. The biological, moral and ethical issues, raised by opponents of the legislation, will not be dealt with since they are well beyond the authority and expertise of the author. In addition, the technical administrative problems involved in operating a system of breeders' rights, such as the problem of adequately defining and distinguishing distinct varieties, or of how varieties will be examined for eligibility for protection, will not be dealt with in this paper. By not considering these problems the author does not wish to imply that they are not important, for some of them are among the most important issues to consider when evaluating this legislation. The consideration of these issues is very important, but is better left to experts in other fields. However, certain non-technical administrative issues are mentioned to indicate their potential significance to the efficient and effective use of plant breeders' rights in Canada.

I. CURRENT STRUCTURE OF THE SEED INDUSTRY[1]

The present structure of the seed industry will affect the impact of the proposed plant breeders' rights legislation, and will in turn, be affected and changed by it. Thus, it is useful at the start to briefly describe some aspects of the structure of the seed industry. The seed industry is a small but significant sector of agriculture, with sales totalling more than $325 million in 1982. As was pointed out in the introduction, the seed industry is not one but many industries. The major activities in the seed industry are research and breeding, multiplication, processing and distribution. Firms in the industry may be involved in just one or in a range of these activities. In addition, distinct sectors of the industry are apparent, so that several related crops can be considered together. These groupings result from a variety of institutional and technical factors. The sectors of the seed industry that are considered include cereal, oilseeds and other field seeds; forage and lawn seeds; corn; special crops; and garden and vegetable seeds. Ornamentals, flowers, and potatoes, although they will be affected by plant breeders' rights legislation, are not considered here.

Plant Breeding

Plant breeding is the basis of the seed industry. New varieties are constantly being developed to increase yields, increase resistance to disease and pests and to extend the production of crops into new areas. Continued plant breeding is required to both maintain and increase crop yields as a result of the reduced resistance to disease and pests of existing varieties that develops over time.

The plant varieties[2] used in Canada are obtained from a variety of sources. The most important source of plant varieties[3] in terms of numbers of varieties is the breeding program of Agriculture Canada

at research stations across the country. Importance based on acreages provides a slightly different ranking. With the exception of Prairie grains, information is not generally available on the actual use of specific varieties. For cereal and oilseeds grown in the Prairies, the Prairie Grain Variety Survey for 1981 indicated that 45 of 73 varieties grown were developed by Agriculture Canada. Although this represented 62 percent of varieties by number, Agriculture Canada varieties accounted for almost 80 percent of acreage seeded.[4]

The next major source of varieties (by number) is imports of both public and private varieties. The share of foreign varieties used in Canada increases substantially if the large number of corn varieties obtained from the U.S. are included. Canadian universities and provincial research stations are the third source of varieties used in Canada. In most cases, the provincial support to plant breeding is channelled through provincial university plant breeding programs. One exception is Alberta, where the province supports plant breeding both through the University of Alberta and through an internal plant breeding program. Provincially supported breeding in Alberta is specialized so that work conducted at the university is not duplicated by the provincial department of agriculture. Quebec appears to operate in the same way since varieties are released separately by MacDonald College and by the provincial department of agriculture. Finally, private varieties bred in Canada are the fourth and final source of varieties. Private varieties bred in Canada become third most important if corn varieties are included. However, this may provide a somewhat misleading impression of the total contribution of the breeding output of the private sector in Canada since many of the inbred lines used by seed companies to produce hybrid corn varieties are developed by Agriculture Canada, with the relatively simple crossing for hybrids being conducted by the firms.[5]

Considering all sources of plant varieties, the total breeding effort on a crop is affected both by the current and expected importance of the crop and by the difficulty or complexity of breeding that particular crop. Usually, there are several different sources of new varieties for each crop with a number of public, private and foreign breeding programs for each. Agriculture Canada and private firms may have a number of breeding programs in different locations for the same crop. This results from the fact that soil and climatic differences as well as end use needs create different requirements for new varieties. The complex requirements of breeding certain crops, (wheat and tobacco for example), have meant that many other plant specialists such as plant pathologists and physiologists are also involved in breeding programs. In some cases these complexities have meant that certain crops, such as wheat, are not bred by private firms, although it is a major crop on the Prairies, accounting for a large share of Western acreage.[6]

The breeding complexities and varied requirements mentioned above create several distinct niches or opportunities for breeding work in each crop and for obtaining varieties either through breeding or through imports. In all classes of crops, imported varieties fill gaps left by public and private breeders. This is true even for crops which are bred by all of the three sources of varieties in Canada, federal and university programs and private breeding programs. Imported varieties include public and private varieties in the same proportion as Canadian varieties, that is, most, but not all, varieties for most crops are public, while most varieties of hybrid crops such as corn are private. However, it should be noted that not all private breeding programs are focused on hybrid varieties. The current sources of varieties reflect the relatively recent growth of private breeding programs in a number of countries. Public varieties have predominated in most crops since public breeding programs have existed for a long period. The continued growth of

private breeding efforts will be reflected by increased use of private varieties. This is seen in the case of soybeans, a major crop for private breeding in the United States. Of the thirty varieties that originate in the U.S. and are used in Canada, twenty-two are private varieties.[7] Soybeans are a self-pollinated crop. A similar result is true for sunflowers where eighteen of twenty U.S. varieties used in Canada are private.[8] Hybrid varieties of sunflowers have been developed in the last decade.

Canadian public varieties supply the bulk of varieties used on the Prairies. In contrast, imported varieties are used particularly in Eastern Canada where acreages have not been sufficient to warrant Canadian breeding programs, public or private. In cases where Canadian breeding programs have developed, both public and private programs, they often started following the importation of suitable varieties, the establishment of a new and viable crop, and the evaluation and testing of further imported varieties. The establishment of a domestic breeding program is the final step. In addition, as a crop increases in importance in Canada, the need for a number of varieties exhibiting different, specific characteristics increases. Thus, varieties suitable for regional characteristics are required after a crop has become established, whereas at first one or two varieties may be sufficient. This process may work in both directions, as in the case of rapeseed, where improved Canadian varieties increased the value and importance of that crop. The transition from testing to breeding is now occurring for a number of crops. U.S. firms have been evaluating hybrid corn varieties in Canada for a number of years, and a few firms have started to develop both hybrids and inbred parent lines in Canada. In addition, a number of U.S. firms are testing and evaluating soybean varieties in Ontario.[9]

In some cases, varieties are widely available, while in other cases, varieties are only available to contract producers. For example, specific varieties are released to contract producers of vegetable crops by the canning companies and to producers of special crops such as mustard which are destined for the export market. This also applies to some malting barleys and to some corn varieties grown for high fructose corn sweetener (HFCS). This type of restricted contract production of a final crop should not be confused with contract production of seed crops or contract production of seed for the export market under the OECD Seed Scheme.[10]

As indicated earlier there are always opportunities to breed improved varieties for all crops.[11] Improvements may be obtained by the development of Canadian breeding programs or by imported varieties. Imported varieties could be expected to continue to serve markets too small to warrant public or private breeding programs in Canada. The current state of plant breeding research and the likely effect of plant breeders' rights legislation will be considered in more detail in Section IV.

Multiplication of Seed

Following the breeding of a new variety, it may be released for commercial development. The small amount of seed produced by the breeder must be multiplied, under strict quality standards to maintain varietal purity, to quantities sufficient for commercial use as seed by farmers. This process, which is known as pedigreeing or certification, is regulated by the Canadian Seed Growers' Association (C.S.G.A.). Pedigreed seed is subject to stringent regulations, that vary by crop, to ensure that the seed purchased by farmers, which may be several generations removed from the breeders' original seed,

remains true to the variety. All varieties offered or advertised for sale or imported for sale in Canada must be prescribed by the Minister. These crops are those licensed by the Seeds Act Variety Order. Prescription (licensing) under the Seeds Act applies to cereals, field crops and oilseeds, forages, lawn and turf seeds and special crops. For this to occur, the variety must be shown to have merit for Canadian agriculture, that is, to be equal to or better than varieties currently licensed under the Seeds Act.[12] These varieties are listed in the Seeds Variety Order. With the exception of a few crops such as some lawn species, sorghums, and sudans, the use of variety names is restricted to pedigreed seed. Varieties of roots, herbs, vegetables and flowers are not required to be licensed (prescribed) for sale in Canada, and there is no restriction on the use of variety names for these crops.

Under the Seeds Act, Regulations are in effect for all crops with respect to mechanical purity (freedom from weeds, inert matter, etc.) and germination requirements. These regulations apply to both common (non-pedigreed) and pedigreed seed.

The Seeds Act recognizes the Canadian Seed Growers Association (C.S.G.A.) as the official pedigreeing agency in Canada.

The pedigree or certification system covers standards for varietal purity and prescribes how specific crops may be multiplied as seed. It is recognized by other countries having similar systems for ensuring the quality and varietal purity of seed, and Canada recognizes the certification standards of some other countries. This ensures that seed may be traded and uniform quality will be assured.

The multiplication of seed is a major activity and seed growers have tended to become specialists in a particular crop or in a particular level of multiplication. The process and pattern of multiplication

for different crops varies as a result of a number of factors. These factors also affect the supply and price of seed available to farmers. For example, the type of reproduction, i.e. self-pollination, cross-pollination or hybrid, is one factor affecting the rules for multiplication in the pedigree system.

The location of seed multiplication and the potential for bringing additional seed to an area if demand warrants is affected by its bulk and weight relative to its price and its alternate uses, especially in the case of grain. The quantity multiplied from Breeder Seed to Select Seed (an intermediate generation between Breeder Seed and Certified Seed, the class of seed sold to producers), is a key determinant of the eventual supply of seed. About 1,000 of the approximately 6,000 seed growers in Canada are qualified as Select growers by the C.S.G.A. These Select growers determine, by their choice of what they grow, how much seed will be available for multiplication to Certified seed by all seed growers, and thus, by implication, they affect eventual supply.

Select growers may or may not own their seed production. In some cases, they multiply seed on contract for private companies who then take back their entire crop. In this case, the seed company rather than the grower controls supply. Public varieties are released, often through SeCan, to Select seed growers who then take the responsibility and risk of producing and marketing the variety.

Most seed used in Canada is multiplied domestically although there are exceptions. At present, all hybrid sunflower seed is imported since there are no Canadian commercial growers of hybrid sunflower seed. Many of the lawn and forage seeds are imported, at least in part. There is a greater tendency to import lawn and forage seed since transport costs do not significantly affect the price of these types of seed since the weight to value ratio is relatively low. Multiplication in other countries may also occur when a new variety is

being released on the market and two generations are produced in one year to speed multiplication of the variety to commercial quantities. This is done by growing higher generation seed in a milder climate or in the Southern Hemisphere during our winter season, with a second multiplication in Canada during the summer season.

In the past, Canadian seed growers were successful in producing seed for markets in Europe and the United States. Often this was uncertified (non-pedigree or common) seed of forage or lawn species. Canadian growers have not exported as much seed in recent years to these markets since most traded seed is now pedigreed. There is very little trade in common seed and Canadian growers have often not switched to the more costly, difficult and exacting production of certified seed. For some species, Canadian growers do not fully supply even the Canadian market for pedigree seed (double cut red clover is an example) so that some of our requirements are served by imports. Canadian growers do not suppy the domestic market with enough pedigree seed to meet demand since the market risk is very high and the profit potential is low.

About 80 percent of hybrid seed corn used in Canada is produced in Southern Ontario, although many of the parental inbred lines are developed and produced in the United States. Inbred lines may both be bred and produced by the private seed companies themselves, or bred by other specialized companies, the universities and land grant colleges, and then multiplied by firms called "foundation seed organizations". These firms specialize in producing and maintaining inbred lines as a service to other firms. The production of hybrid corn seed from inbred lines using a single cross, double cross or three-way cross requires careful control and field supervision by the grower. In addition, yields of seed are low so that growers receive a relatively high price for seed. Hybrid seed growers in Ontario are organized into a marketing board for negotiation of their contracts with the seed firms. About twenty percent of Canada's hybrid corn seed requirements are imported, although an equivalent amount of seed is exported from Canada to the United States and Europe.

Most vegetable seed used in Canada is produced in the United States which enjoys both a larger domestic market and a more favourable climate for seed production. However, vegetable seeds are also imported from a number of other countries including Israel and Japan.

Seed Processing

Seed processing includes cleaning, drying, separating of desired seed from other seeds and plant material, sorting of seed by size or shape (if needed for mechanical planting) and treating the seed with various chemicals such as pesticides or fungicides if required. There are differences in seed processing by crop and by region of the country. Seed processing facilities may be owned by the grower or by the seed wholesaler or retailer. In some cases, particularly in the Prairies, there are local municipal processing facilities. Seed may be packaged in bulk or bag form. Seed processing may add significantly to the price of seed for certain species as a relatively high proportion of the seed may have to be discarded to meet certification standards for purity. Examples of this are forage and lawn seed where it is relatively difficult to weed out all impurities.

The current lack of appropriate seed cleaning facilities may limit the production of certain kinds of seed in Canada, since the potential scale of seed production of, for example, a number of vegetable crops, may not be sufficient to warrant investment in seed cleaning equipment.

Seed Distribution: Wholesaling and Retailing

The firms involved in selling seed to Canadian farmers are heterogenous in terms of their size and activities. Many firms active in retailing seed are also involved in other aspects of the seed

industry, processing, multiplying and breeding new varieties. The participants in seed distribution also vary according to the crops that they deal in and their region.

Not very much information of the kind needed by economists is available for this or any other sector of the seed industry for the study of market structure. Data on market share, number of buyers and sellers, size of firms, concentration, barriers to entry, or costs are not available. This section, like those before it describing other parts of the seed industry, uses basic descriptive information rather than analytical data on industry structure. Part of the difficulty in developing data on seed industry market structure would be found in determining the boundaries of relevant markets based on geography and type of crop.

Seed wholesalers and retailers may be classified by crop type, by the form of ownership and by primary activity. Classified by ownership, seed distributors include large and small family firms (often privately held companies or unincorporated firms), agricultural co-operatives and incorporated companies. By activity, seed distributors include firms primarily active in wholesaling and/or retailing seed as well as firms active in other parts of the seed industry such as research or multiplication. They also include firms primarily active in other activities or industries, with seed distribution as a secondary activity. Examples of this sort of diversification include the western and eastern co-ops and pools, contract grain and specialty crop producers, farm supply firms, oilseed crushers, canning firms, and chemical and pharmaceutical firms. Diversified firms in the seed industry are more likely to be foreign-owned than are undiversified firms. Foreign-owned firms have participated in the Canadian seed industry for a number of years, mostly in the hybrid corn sector. Foreign-owned firms are now becoming more active in the Canadian seed industry.

Seed Firms: Acquisitions and Diversification

Conglomerate diversification occurred more frequently in the seed industry during the seventies than in the past, in a manner similar to many other sectors in the economy. Previously, diversification into and out of the seed industry had usually involved horizontal or vertical relationships between firms.[13] For example, a firm active in supplying farm inputs, including seed, could be described as horizontally integrated, while a canning company that owned and supplied its own varieties to producers could be considered vertically integrated. More recently, firms in industries not directly related to seed have been acquiring seed firms.[14] In these cases other factors explain the pattern of diversification. Factors such as a common marketing strategy or research intensity may explain the acquisition of seed firms by chemical and pharmaceutical companies such as Sandoz Chemical Company or Ciba Geigy Canada Limited. For example, a firm engaged in pesticide, herbicide, or fertilizer research may view plant breeding as a useful complement to its current activities. With plant scientists already engaged in research, there may be sufficient commonalities to warrant extension into plant breeding. In other cases, new developments in the area of biological-chemical research for pharmaceuticals may provide an advantage with new developments in the technology of plant breeding. Although these firms are global in scale and are now active in the seed industry in a number of different countries, it is believed that they currently occupy a relatively small share of the Canadian seed market, often serving specialized needs.

Concern has been expressed that multinational firms are acquiring large numbers of independent Canadian seed firms. In addition, some critics of the proposed Plant Breeders' Rights legislation argue that the legislation will encourage further take-overs.[15] Although major acquisitions in the seed industry have occurred during the last

five to ten years, similar acquisitions by larger firms often outside the seed industry have also occurred in other countries as well.16 Table A presents information on acquisitions of Canadian seed companies by foreign firms since 1975. These acquisitions17 were subject to review by the Foreign Investment Review Agency. It is not known whether there were any acquisitions by Canadian-owned firms, other than the acquisition of Maple Leaf Mills' forage and turf seed division by Otto Pick and Sons Seeds Limited, since systematic information is not available on acquisitions by domestic firms. In part, this trend reflects a general shift that has been occurring in farm input industries since the sixties. During that decade in the United States, many smaller family-owned firms, including seed companies, were taken over by larger firms. In many of these cases, the firm had either become too large for the owning family to manage or the next generation did not want to keep the business. A number of these acquisitions were seller-induced.18 It may well be the case that this phenomenon has been occurring in Canada more recently in the seventies and eighties.

The logical relationship between increased merger activity and the proposed Plant Breeders' Rights legislation is uncertain.19 The acquired firm must have a breeding program and/or varieties that may be protected and are likely to be a commercial success for the acquiring firm to obtain an advantage that is related to the existence of variety protection from the merger.

If there were founded concerns about the growth through merger of conglomerate firms in the seed industry, they could perhaps be regulated by the Foreign Investment Review Agency. Internal growth through success in the marketplace should not and could not be regulated in

TABLE A. SEED INDUSTRY ACQUISITIONS,[1] 1975-1982

I Acquiring or Acquired Firm with Breeding Programs in Canada

Acquiring Firm	Activity	Acquired Firm	Activity	Year
Maple Leaf Mills Ltd.[2]	Flour mills, animal feed plants, forage and turf seeds, hybrid seed corn, grocery products.	Maxville Feed and Seed Co. Ltd.	Distributor of feed, seed, fertilizer and farm supplies.	1975
Ciba-Geigy Canada Ltd.	Wide range of chemical and pharmaceutical products, agricultural chemicals, seed activities in U.S. and elsewhere (cereal, pedigreed grain, hybrid seed corn).	Stewart Seeds Ltd. Funk Seeds International of Canada.	Producer of hybrid corn and and specialty cereal seed. Corn Seed Producer.	1975
Pfizer Chemicals and Genetics Ltd.	Chemicals, animal feed and supplements, pharmaceuticals, animal health products, hybrid seed corn.	Warwick Seed Co. Ltd.	Produces hybrid seed corn.	1976
Northrup King & Co. Sandoz Seed Co.	U.S. seed company active alfalfa, hybrid corn, sunflower, soybeans and wheat. Pharmaceuticals, chemicals, seeds.	National-NK Seeds Ltd.	Wholesaler of seeds, Breeds hybrid corn.	1977
Ciba-Geigy Seeds Ltd.	Seed division of Ciba-Geigy Canada Ltd. (Incorporates Stewart Seeds Ltd. and Funk Seeds International of Canada).	Hybridex Inc.	Retailer of cereal and forage crop seeds and agricultural chemicals.	1978
Maple Leaf Mills Ltd.[2]	Flour mills, animal feed plants, forage and turf seeds, hybrid seed corn, grocery products.	Hagersville Elevators Ltd.	Grain storage and handling, sale of seed and other farm supplies.	1979
Otto Pick and Sons Seeds Ltd. (Canadian-owned)	Breeds, produces and retails seed.	Forage and turf seed division of Maple Leaf Mills Ltd.	Breeds, produces and wholesales forage and turf seed	1981
Dekalb Ag Research, Inc.	Agricultural supply, seed corn activity	Pfizer Chemicals and Genetics Inc.	Seed Corn Division	1982

II Acquiring or Acquired Firms without Breeding Programs in Canada[3]

Acquiring Firm	Activity	Acquired Firm	Activity	Year
Canadian Industries Ltd.	Chemical manufacturing, some farm supply distribution.	Hutton Farm Supplies Ltd.	Farm supply distributor	1975
de Beaujeu Agromart Ltd.	Unknown	L.C. Curran Mills Ltd.	Retailer of feed and seed.	1976
Betaseed Inc.	Unknown	Ladner Beetseed Division of B.C. Sugar Refining Co. Ltd.	Processor of sugar beet seeds.	1977
Cargill Grain Co. Ltd.	Animal feeds, poultry, grain merchandising, seed breeding and distribution.	Seed Plant Dept. of Kroeker Seeds Ltd.	Retailer of seed and fertilizer.	1978
Constituent Merger Corp.	Holding company	Harris Seeds of Canada Ltd.	Retails vegetable and flower seeds.	1978
Continental Grain Co. (Canada) Ltd.	Large diversified grain merchandising firm.	part of Hannas, Hannas, Hannas Consultants Ltd.	Stores and handles clover and grass seeds.	1978
Cargill Grain Co. Ltd.	Animal feeds, poultry, grain merchandising, seed breeding and distribution.	Mighty Peace Grain Ltd.	Grain storage and handling, sale of seed and other farm supplies.	1979

[1]This information is neither comprehensive nor complete with respect to acquisitions by Canadian owned firms. All acquisitions by foreign owned firms subject to foreign investment review have been included to the best of the author's knowledge.

[2]Maple Leaf Mills Ltd. was considered to be a foreign owned firm at the time of these acquisitions since it was controlled by the Norin Corporation.

[3]At the time of these acquisitions, these firms did not appear to have breeding programs in Canada. Some have since developed breeding programs in Canada.

Source: FIRA Annual Reports 1975-76 to 1982-83 and press reports.

this manner, of course. However, certain abuses of market power could be dealt with by the provisions of the proposed plant breeders' rights bill for compulsory licensing. Finally, the best protection against abuses of market power is the prevention of the growth of market power. It is not evident that plant breeders' rights by themselves would promote the growth of market power to the extent that there would be a potential for abuse.

Seed Distribution: Contract Seed Production and SeCan

Two aspects of seed distribution will be discussed here. These are contract seed production and its effect on seed distribution, and SeCan, the association used to promote and market public varieties developed by Agriculture Canada and the universities and to generally promote the use of pedigreed seed.

Contract production, mentioned above in the section on seed multiplication, is becoming more common in the seed industry. While contract production has always occurred to some extent, it has become more frequent since changes to the Regulations under the Seeds Act in 1973 enabled a de facto form of variety protection. Select and Certified seed growers may operate either independently or by various kinds of contracts. If they operate independently they may choose to sell the seed they produce either directly to farmers or to firms specializing in seed processing and retailing, or to other growers for further multiplication to certified seed. In either of these three cases, the seed grower is an independent businessman, who owns his production and can release it to the market as he chooses. Traditionally,[20] seed growers could multiply seedstock of any public variety for which they believed a market existed. By operating independently, the earnings of a seed grower depended on the price of seed and his costs. As has been mentioned, the multiplication of seed is a relatively costly operation, often quite labour-intensive. The price of both pedigree and common seed varies considerably from year

to year with large swings possible from demand-supply imbalances. The independent seed grower, then, operates what can be a relatively risky business with a potentially high variation in earnings. Multiplication by independent seed growers was the case for most public varieties before the establishment of SeCan in 1976. Since the advent of SeCan, even growers producing varieties released by SeCan on contract are operating independently. Although growers are restricted in the sense that they must only sell Certified seed and must collect a royalty if required by the breeder, they do operate as independent businessmen in several senses. The grower still must price his Certified seed to meet the prices charged by other growers of that variety and of other varieties. The grower estimates what his final market for Certified seed of that variety is likely to be and obtains enough higher generation seed stocks to breed the desired amount of Certified seed. The grower thus operates independently and bears the associated market risk.

For private varieties, growers produce seed under a contract system and they do not own or control the seed they multiply. Select growers receive Breeder seed from seed firms to multiply only if all the Select or Foundation seed that they produced is returned to the seed firm, with the seed grower receiving his return, not from the sale of seed but from a fee for his services from the seed firm. Thus, operating on contract to a private company can assure more stable earnings than operating independently. The seed firm contracting for production bears the market risk of producing the varieties demanded by farmers in the correct quantities. Contract production is now common for private varieties of hybrid corn and forage and lawn species. It should be noted that this is a very different type of contract system than that used to control the release of public varieties by SeCan.

Most federal and university varieties are now released on a restricted basis to SeCan. SeCan is an association[21] whose purpose is to multiply and promote the use of new public varieties and to promote the use of pedigreed seed in general by advertising. SeCan has been in operation since 1976 and by 1983 was handling one hundred and two varieties, of which seventy-eight had been developed by Agriculture Canada, two by MacDonald College, eight by the University of Saskatchewan, eight by the University of Guelph, two by the Alberta Ministry of Agriculture, two by the University of Manitoba and two by the Quebec Ministry of Agriculture. The number of varieties handled by SeCan has increased substantially since 1979 when only thirty-five varieties had been released to the association.[22]

Membership in SeCan is available to firms and enterprises active in the seed industry from multiplication to merchandising. However, most members are seed growers. By the end of 1983, there were approximately 2 400 members of SeCan, of whom 2 300 were seed growers. The remainder are seed trade firms. There are approximately 6 000 seed growers in Canada, with about 1 000 of these qualified to be Select growers, multiplying the first generations from Breeder Seed. Thus by 1983 a growing proportion of Canadian seed growers were members of SeCan. Comparable figures for 1979 were 325 members, with 275 of these seed growers.

Varieties are released by the breeder or his institution to SeCan, which then releases the variety to members for multiplication and sale. The breeder can set the conditions for release of his variety, subject to negotiation with SeCan, and can charge SeCan with collecting a royalty for the variety on his behalf. These conditions are formalized through a contract between the breeder and SeCan.

SeCan may then release the variety to its members in one of two ways. SeCan may choose to release the variety to any member interested in growing the variety by a general release. Alternatively, it may

release varieties on a restricted basis to one or two members if the variety appears to have a particularly small potential market. SeCan's preference is for general release (but it must be remembered that this is still restricted to members of SeCan) over restricted release.[23] Varieties are released to members through a contract outlining the conditions of release, determined both by the breeder and by SeCan. The contract ensures that certified seed is the only seed sold and that higher generations of seed (select, foundation and registered) are not sold commercially. However, growers may arrange transfers of higher generation seedstock by prior arrangement with the approval of SeCan. Growers may be levied fines or penalties if the terms of the contract are breached or if seedstock of the variety is given to anyone without SeCan's prior approval. The penalties are calculated as the royalties and levies that would have been paid on the certified seed produced with that seedstock. SeCan is also responsible for promotion of the varieties it is responsible for and does this through co-operative advertising with its members, financed by a levy on sale of certified seed and a membership fee. The levy on the sale of seed, set at 4% for the first year a variety is widely available and at 1% for subsequent years, is in addition to any royalty collected on behalf of the breeder. The levy is calculated as a percentage using dollars per tonne of the average selling price. The percentage levy may be changed to a per unit levy (a levy per kilogram of seed sold) in the future.[24]

Size and Overview of the Seed Industry

The seed industry is a small but highly significant participant in the agricultural sector. Seed sales amounted to more than $325 million in 1982, representing about 3 percent of total farm operating expenses.[25] The potential size of the seed industry is much larger than it is at present. Purchased seed represents only a portion of the seed used by Canadian farmers, since many farmers process and plant seed from the previous year's crop. The seed that is sold commercially[26] to Canadian farmers may be either pedigreed (certified) or common (commercial) seed. Pedigreed seed is classified

according to the regulations of the Canadian Seed Growers Association and is sold by variety name. Common or commercial seed, on the other hand, may not be sold by variety name (although it may be based on a variety) and is classified only in terms of the purity standards of the Seeds Act, and designated as Number 1 or Number 2 quality. The seed saved and planted by farmers is often called bin-run stocks.

It is relatively difficult to estimate accurately the proportion of purchased (pedigreed and common) seed sales to total seed sales or the proportion of pedigreed seed sales to total seed sales. Farmers have been shifting extremely slowly both to purchase commercial seed and to purchase pedigreed seed to take advantage of the higher germination rates, higher yields and lower weed counts associated with these kinds of seed in contrast to their own bin-run stocks. However, the seed for certain crops, such as hybrid corn, consists entirely of pedigreed seed. In the case of corn and other hybrids, new seed must be purchased each year since hybrids do not reproduce true to type in the next generation. For crops other than hybrids, farmers have the choice of planting their own seed, or purchased common seed or pedigreed seed. Many opt for their own seed or common seed apparently because these are less costly. Premium prices are asked for pedigreed seed since its production is more costly, and expected crop yields using it are higher. Some evidence shows that the practice of using bin-run stocks or even common seed can be a false economy in certain circumstances.

Several surveys of the seed planted by farmers show remarkably similar results. In Alberta in 1980, sixty percent of the seed planted for cereal and oilseed crops was the farmer's own seed while 19 percent was purchased from other farmers.[27] The remaining twenty percent was obtained from seed growers or seed firms.[28] Similar results were found in Manitoba in 1976 when 81.0 percent of seed planted was the farmer's own seed or purchased from another farmer.[29] Only 19.0 percent was obtained from a seed grower or seed firm.

The Manitoba survey indicated that 55.0 percent of the seed planted was ungraded, 30.0 percent was of commercial quality (common), while the remaining 15.0 percent was pedigreed of either registered or certified (bulk or bag) quality. These proportions varied considerably among the specific crops surveyed in Alberta, with almost 35 percent of flaxseed being registered or certified pedigreed seed and 64 percent of rapeseed being pedigreed. The Manitoba survey indicated that almost 11.0 percent of wheat seed in 1976 was pedigreed seed while comparable figures for barley and oats were 20 percent and 8 percent respectively.

An alternate way of examining this is to estimate the availability of pedigreed seed in relation to total seed requirements. In 1978, the CSGA estimated that pedigreed seed was available for 14 percent of seeded acreage for wheat, 31 percent of barley acreage and 30 percent of oats acreage.[30] Similar calculations cannot be made for many other crops.[31] Although estimates have been made for wheat, barley and oats, figures such as these indicate the dangers and limitations of the data available on the seed industry. For example, the following table, Table B, estimates the proportion of prairie acreage seeded to pedigreed seed in 1980 based on disappearance data. The drill surveys in Alberta and Manitoba reported above may contain more accurate information since they reflect what farmers were actually planting rather than the potential pedigreed seed available.

The source of seed in both Alberta and Manitoba is reflected in the grade of that seed under the standards of the Canada Seeds Act. In Alberta, over twenty percent of the seed samples of the farmer's own seed, or seed obtained from other farmers, would have been rejected on the basis of germination rates and weed counts. In contrast, less than ten percent of samples from seed growers or seed firms were rejected. More than eighty percent of the samples from seed growers and seed firms were graded as Number 1 seed while the same was true

TABLE B. Percentage of Prairie Acreage of Major Crops Seeded with Pedigree Seed, 1980

Crop	Canadian Seed Growers Assoc. Estimate[2]
Wheat	15.4 (14)[3]
Barley	32.8 (31)[3]
Rapeseed	119.8 (100)[3]

[1]Certified seed production calculated from estimated yields of inspected acreage, with adjustment of carryover stocks to obtain availability of certified seed. Data on seeded acreage were obtained from the Prairie Grain Variety Survey of the Canadian Co-operative Wheat Producers Ltd.

[2]The figure in brackets is an estimate made by the CSGA for 1978.

for only sixty percent of own seed or other farmer's seed samples. In Manitoba, where only aggregate figures are available, 44 percent of samples were rejected while only 30 percent were graded as Number 1.

These facts are significant for three reasons. In the first place, they indicate important features about the purchasing behaviour of farmers. Farmers will avoid paying the premium price for pedigreed seed and, in many cases, avoid even common (commercial) seedstocks in favour of their own seed or seed obtained from another farmer. This is so despite the lower quality of that seed, and the demonstrated example of the relative increase in yields and returns from using pedigreed seed.[32] This behaviour may, in some cases, be a result of a lack of information on the yield and benefits of pedigreed seed while, in other cases, it may be result of rational decision-making for the production of a secondary crop. A secondary crop may be considered to be a non-cash crop, a crop grown for internal use on the farm. A farmer may put more effort and expense into a cash crop, buying seed and applying herbicides, pesticides and fertilizer as needed, than he puts into a crop that he does not intend to sell.[33] Another way of expressing this is to distinguish between extensive and intensive crop production. The use of pedigreed seed is much lower in the Prairies than in Eastern Canada, and in both areas it is concentrated in specific crops. Most cereal production is extensive crop production in which farmers will attempt to minimize input costs wherever possible. With intensive farming and the possibility of higher cash returns, for instance in soybeans and canola, the farmer will invest in pedigreed seedstocks and other purchased inputs.

Secondly, these results show the potential growth of the market for purchased pedigreed seed. The growth of the seed industry is dependent both on an increase in demand by farmers and on an increase

in the ability of the seed industry to supply pedigreed seed. An increase in demand by farmers will depend primarily on demonstrations and information that the purchase of pedigreed seed does increase returns when both higher yields and the time and money costs of using their own seed are considered. One source of information to farmers on the merits and qualities of pedigreed seed is advertising.

Advertising has been important for a number of years for marketing hybrid corn varieties to farmers. Advertising and promotion are also becoming more important for marketing varieties of other crops as well. Private varieties have generally been well promoted since it is in the companies' interest to promote sales. Public varieties have fared less well, with concern over insufficient promotion and use being a major motivating factor behind the establishment of SeCan. However, advertising can be both informative and persuasive. There has been concern expressed that advertising levels may become excessive in the seed industry with simple brand promotion taking precedence over the provision of information useful for making purchase decisions. Other sources of information on the merits of pedigreed seed in general, and of specific varieties in particular, should be maintained and strengthened, since these are generally perceived to be either independent of the seed companies or reliable. The ability of the seed industry to supply seed at affordable prices is also a factor affecting potential growth of the seed industry. Pedigreed seed production is relatively costly. In addition, domestic seed prices are affected by the export demand for Canadian seedstocks.

Finally, these results are significant because they indicate the size and potential of the market for royalty bearing seed under plant breeders' rights. Only pedigreed seed sold by variety name will bear royalties. The proportion of seed used that is purchased varies widely from species to species, as indicated above, but is likely below thirty percent for the average of all crops across Canada. Pedigreed seed is, perhaps, half of this amount. Unless farmers change their purchasing behaviour significantly, royalties will be

earned for only a minority of total seed planted in Canada. Further detailed work by crop type would be needed to determine the current size and potential growth of the market for pedigreed seed, in order to predict which crops would be most affected by the introduction of breeders' rights. Crops which rely on a high proportion of pedigreed seed would obviously be the most likely candidates for royalty-financed breeding increases. However, the royalty collected may be split between funds for further research and funds for advertising and promotion[34], reducing the funds available for research.

Section I - FOOTNOTES

1. The section draws heavily on "The Breeding, Multiplication, Processing and Sale of Seed of Varieties for Canadian Agriculture: Who Does What" by W.T. Bradnock, Director of the Seed Division. This section of the paper is not designed to repeat the material contained in Mr. Bradnock's draft background paper, but is included here to provide a brief background for this report.

2. This discussion includes varieties of crops licensed for use in Canada under the Seeds Variety Order. Varieties of garden and vegetable crops are not listed in the Seeds Variety Order.

3. This ranking is based on the statistics presented in Tables D and E (Section IV) covering the major cereal, field and oilseed crops, selected forage and lawn seeds, special crops, potato and corn seed. Not all crops covered by the Seeds Variety Order are considered in these tables.

4. Calculated from data contained in the Prairie Grain Variety Survey, 1981, Canadian Co-operative Wheat Producers Ltd.

5. This appears to be the case in the United States as well since private firms produced over 80 percent of hybrid corn varieties, while public institutions provided the inbred lines used in 50 percent of hybrid corn varieties produced. Vernon W. Ruttan, Agricultural Research Policy, (Minneapolis: University of Minnesota Press, 1982), p. 192, 199.

6. The specific quality characteristics required by wheat and malting barley appear to make these crops unlikely candidates for major private breeding programs.

7. Table D. Data obtained from the Seed Division based on varieties listed in the Seeds Variety Order.

8. Although eighteen of twenty of the U.S. (hybrid) sunflower varieties used in Canada are private, the inbred lines used in these hybrids were, for the most part, developed at the U.S. land grant colleges. Bradnock, op.cit., p.9.

9. Ibid., p.10.

10. The OECD Seed Scheme enables foreign varieties to be multiplied by Canadian seed growers, for re-export to their country of origin.

11. Ibid., p.23.

12. The term "licensing" is used here with caution. This should not be confused with the two forms of licensing proposed in the Plant Breeders' Rights Bill. The term licensing had been used in the Seeds Act until 1959 to denote varieties that were listed in the Seeds Variety Order and could be offered for sale in Canada. Since 1959, this term has been replaced by the term prescription, but the term licensing has been retained on an administrative basis. It will be replaced by "registration" in the proposed revisions to the Seeds Act. Once a variety is licensed it is listed in the Seeds Variety Order and in periodic published updates as a matter of public record.

13. Diversification into the seed industry occurs when a firm outside the seed industry acquires a seed firm, while diversification out of the seed industry occurs when a seed firm acquires a firm active in another industry.

14. There do not appear to have been any acquisitions by seed companies in other industries, thereby diversifying outside their industry. This could be a result of the small average size of seed firms. However, it should be noted that some seed firms or firms dealing in seed as a primary activity are quite large, even on an international scale. Northrup-King and Dekalb are good examples of this.

15. For example, see various issues of Union Farmer particularly (June 1980 to March 1981); Jim Romahn, "Seeds of Discontent", Canadian Business, February 1979; and P.R. Mooney, Seeds of the Earth: A Private or Public Resource?, Ottawa: Inter Pares, 1979, pp.55-63.

16. Evidence for the United States is found in Competition in Farm Inputs: An Examination of Four Industries, Robert F. Leibenluft, Office of Policy Planning, Federal Trade Commission, February 1981, pp. 99-103; and for the United Kingdom in correspondence from the Plant Variety Rights Office.

17. Except one by Otto Pick and Sons Seed Limited, of the forage and turf seed business of Maple Leaf Mills Limited.

18. Arlo J. Minden, "Changing Structure of the Farm Input Industry: Organization Scale and Ownership", American Journal of Agricultural Economics, Vol.52, No.5, December 1970, pp.678-687.

19. Some of the concern over increased merger activity with breeders' rights or variety protection legislation results from inaccurate reports concerning Rank-Hovis-McDougall's acquisition of a large number of small agricultural supply firms about the time that the United Kingdom passed variety protection legislation in 1964.

20. This has changed since federal and university public varieties are now released on a restricted basis to SeCan, which contracts with growers to allow the possibility of royalty collection on the sale of Certified seedstocks.

21. SeCan also has representatives of the seed trade (seed companies) and of federal and provincial governments on its Board of Directors.

22. Talk by L.R. White on SeCan to Joint Meeting of the Western Seed Growers and Seed Trade, October 30, 1979, Winnipeg, mimeo, pp. 1-8.

23. Ibid., p.4.

24. Ibid, p. 6.

25. Agriculture Canada, Market Commentary, Horticulture and Special Crops, December 1982, p. 91.

26. Through seed retailers in contrast to farmer-to-farmer transactions.

27. This category excludes farmer-seed growers.

28. Alberta, Provincial Seed Drill Survey, 1980, p.3.

29. Manitoba, Department of Agriculture, Manitoba Seed Grain Surey, 1976, Table 1.

30. Quoted in Thomas Curren, "Plant Breeders' Rights Legislation for Canada", Research Branch, Library of Parliament, Ottawa, September 25, 1979, p.24.

31. For corn, soybeans and rapeseed, it has been estimated that pedigreed seed is available to seed 100 percent of the acreage seeded. Curren, p. 24.

32. "What do I get for the extra costs?", Seed Scoop, February-March 1980, Vol. 27, No.3, p.3.

33. For example, farmers may produce a crop of secondary importance (to them) making very few expenditures on seed, fertilizer or herbicides. The crop may be used as feed on the farm, or sold if the farmer can cover his (deliberately) low costs.

34. At the present time, SeCan charges a levy on all certified seed sold by members for promotion and administration. This is calculated separately from the royalty, which may be collected by SeCan at the request of the breeder or his institution. (Talk by L.R. White on SeCan to Joint Meeting of the Western Seed Growers and Seed Trade, October 30, 1979, Winnipeg). In the United States, there has been some controversy over the division of royalty funds for research and for promotion. The Missouri Seed Improvement Association has released a variety of wheat bearing a royalty (special assessment) which has been allocated as 25% for research and 75% for advertising and promotion.

II. PROPOSED PLANT BREEDERS' RIGHTS LEGISLATION

This section briefly describes the major features of the proposed legislation. A more detailed consideration of certain aspects will be reserved for Section III which examines similarities and differences between plant breeders' rights legislation and the more familiar and established patent law, and discusses the benefits and costs associated with such systems.

Bill C-32, the Plant Breeders' Rights Act, has three major objectives. These are:

1) to stimulate additional plant breeding research, particularly in the private sector;
2) to improve access to protected foreign varieties that are currently withheld from the Canadian market since complete legal protection is not available for varieties marketed in Canada; and
3) to permit the collection of royalties on Canadian varieties sold both in Canada and abroad.[1]

Bill C-32 creates a legal property right, for the breeder of a new, distinct, stable and uniform plant variety, that is similar in some respects to an inventor's patent or a writer's copyright. Variety protection or breeders' rights legislation has been discussed in Canada and in other countries for a number of years. Canadian legislation is being introduced at this time for several reasons. Our major trading partners in seed stock, the United States, the United Kingdom and most Western European countries, have adopted similar legislation and it is generally believed that trade has been hampered by the lack of this legislation in Canada. There are two effects here. Most importantly, foreign breeders have been restricting or preventing the release of varieties in Canada since there is no procedure for legislated protection in Canada. Although some foreign

breeders have released varieties in Canada through contractual arrangements with seed firms, these arrangements do not provide sufficient protection for all foreign breeders to willingly release their varieties in Canada. Contractual relationships are limited to the jurisdiction in which they may be enforced. In addition, it is possible that private contractual arrangements limiting the multiplication and sale of pedigreed seed may be subject to challenge as a restraint of trade under the Combines Investigation Act. Secondly, the absence of breeders' rights legislation in Canada has meant that Canadian varieties cannot be protected abroad in countries that use the reciprocity option of the Convention of the International Union for the Protection of New Varieties of Plants.

The essential principles of breeders' rights legislation are relatively simple, although there is considerable detail and complexity in certain portions of the bill. A plant breeder will be given exclusive rights to sell and to produce in Canada for sale his variety provided that it meets the criteria for protection. These criteria are that a variety is new, distinct, stable and homogeneous. The rights of the breeder allow him to licence others to produce the variety for sale or to retain exclusive rights to the variety. The breeders' right includes protection for an inbred line used by others in the production of a hybrid variety, or for a single cross hybrid used in the production of a three-way cross or double cross hybrid. The breeder must make his variety freely available for further breeding work, but his inbred line cannot be used directly by another repeatedly as necessary for the production of a hybrid without payment of royalties to the breeder. The breeders' right does not give the breeder any claim to a return from the final sale of an agricultural or ornamental product, the right covers only seed or other parts of the plant, such as roots or cuttings, used for propagation.

In return for the rights granted, the breeder has obligations to maintain breeding stock of the variety and to ensure that the variety is widely available at reasonable prices. The term of the right is for a maximum of eighteen years from the issue of the certificate of registration of the right.

A Registrar of Plant Breeders' Rights will be appointed. He will be able to refuse to grant rights or can revoke, suspend, annul or amend the rights granted to a breeder. The rights granted by the Registrar of Plant Breeders' Rights may be revoked if a rights holder violates certain conditions associated with the grant. These include the failure to maintain a stock of propagating material, non-payment of fees, failure to meet the conditions of a compulsory licence, and commercial sale of the variety before rights were granted.[2] Revokation of rights is an extreme measure and is unlikely to be used unless other measures have been tried unsuccessfully. In the case of patents, a Canadian patent has never been revoked although there are provisions for this.[3] Fees will be charged by the Registrar for services associated with granting the right and for maintenance of the right through its term.[4] The breeder may abandon his right before the period of protection expires, if the variety is no longer in significant commercial use.

There are a number of safeguards built into the legislation to ensure that rights are not abused. The safeguards which are likely to be used most frequently include the provisions for automatic and compulsory licensing. These provisions are also related to the provision for exclusive production and sale that have been proposed in Bill C-32. Exclusive licensing would allow the breeder to have exclusive rights to sell or to produce for sale the variety either for

a few years or for the entire period of protection, exempting the variety from the potential use of either automatic or compulsory licensing. Species would be selected in advance for eligibility for exclusive licensing, compulsory or automatic licensing.

The general compulsory licensing provisions of Section 25 of Bill C-32 will apply to all species not specifically designated for Section 26, automatic licensing. The objective of Section 25 and the principle used to guide the Registrar of Plant Breeders' Rights in granting a compulsory licence and in setting its terms (primarily the royalty to the breeder) is that a "plant variety is made available to the public at reasonable prices, that it is widely distributed, that it is maintained in quality and that there is reasonable remuneration for the holder of the plant breeders' right respecting the plant variety".[5] A prospective licensee may apply to the Registrar for a compulsory licence if he has been denied a voluntary licence by the holder of the right. The Registrar is obliged to grant the licence, setting terms including the royalty, unless there is good reason to refuse the application. The terms of the licence may be changed and the licence itself may be revoked or extended by the Registrar at any time. The legislation permits regulations exempting certain species from the compulsory licensing provisions for a number of years or for the entire term of the breeders' right. This may be done, on the advice of the Advisory Committee, when it is required to provide the breeder with an adequate return on his breeding investment.

Under the automatic licensing provisions of Section 26, anyone will be granted a licence automatically for a variety of designated species. Species will be designated with the advice of the Advisory Committee. Licences may be revoked by the holder of the right for good cause, which could include, by way of example, the fact that a licensee sold poor quality seed.[6] For automatic licensings, royalty rates would be set by agreement between the right-holder and the licensee.

The provisions for exclusivity, limited exclusivity, automatic and compulsory licensing allow species to be treated in a number of distinct ways. This is in contrast to patent legislation where separate rules apply only to food and pharmaceutical products. Tailoring the patent system for specific industries has been resisted since it is not a practical alternative with the number of industries affected.

A companion bill introduced at the same time as Bill C-32 is Bill C-33, An Act to Amend the Seeds Act. Amendments are being introduced now to strengthen the provisions of the Seeds Act and its Regulations that ensure that only superior varieties with merit may be sold in Canada.[7] The provisions for registration of varieties (now called variety licensing) are being given a firmer legal basis to enable the registration system to withstand any legal challenge by private firms seeking to release protected varieties in the market. Registration applies only to crops listed in the Seeds Varietey Order.

Section II - Footnotes

1. These objectives are outlined in a document released with the introduction of Bill C-32, Plant Breeders' Rights for Canada - The Reasons for Legislation, Agriculture Canada, mimeo, 1980.

2. Bill C-32, Sections 23(1)(a), 15, 21, 25, and Section 27(2).

3. Economic Council of Canada, Report on Intellectual and Industrial Property, (Ottawa: Information Canada, 1971), p. 66.

4. This technique has not been used in the Canadian or American patent systems although it is quite common elsewhere. F.M. Scherer, Industrial Market Structure and Economic Performance, (Chicago: Rand McNally College Publishing Co., 1980), Second Edition, p.455). The American plant variety protection system charges a single fee at the start and no further payments are necessary to keep the right in good standing during its term. In contrast, most European countries charge annual renewal fees to maintain a breeders' right.

5. Bill C-32, Section 25(2).

6. Clause-by-Clause Explanation of the Plant Breeders' Rights Bill, (Bill C-32), Seed Division, p. 8.

7. Prescription (licensing) under the Seeds Act applies to cereals, field crops and oilseeds, forages, lawn and turf seeds and special crops. Varieties licensed under the Seeds Act are listed as a matter of public record in the Seeds Variety Order.

III. THE PLANT BREEDERS' RIGHT AS AN INTELLECTUAL PROPERTY RIGHT

The nature of the proposed Plant Breeders' Rights legislation, creating an intellectual property right based in law, and its objectives suggest that it would be useful to consider it using the framework developed for the economic analysis of patent law. While it has been recognized, as outlined below, that the patent system itself is not the appropriate legislative framework for ensuring that plant breeders have a legal right to the varieties they develop and can earn a return for their research effort, the legislation is similar in many respects to existing patent law. This part will compare the goals and objectives of both the Plant Breeders' Rights Bill and the Patent Act. The benefits and costs of patents suggest the likely benefits and costs of a system of plant breeders' rights. Licensing mechanisms and the term of the patent or breeders' right are considered in relation to optimal patent design, maximizing net benefits of the system.

A Separate System of Reward

In 1958, the Isley Royal Commission on Patents, Copyright and Industrial Designs considered the subject of patents for certain plant varieties.[1] It received representations from the Canadian Horticulture Council to the effect that the patent system should be extended to include plant varieties which are asexually reproduced. The Royal Commission, in its report, disagreed on a number of grounds, primarily that plants could not meet the requirements and characteristics of patents, especially additions to the public knowledge through disclosure.[2] An inventor granted a patent right is required to make a public disclosure of the invention in order to encourage the production of knowledge and further innovation activity. Even with full and informative patent disclosure, it is uncertain whether disclosure fulfills the purpose of permitting others to obtain the know-how required to reproduce the patented invention. The Royal

Commission suggested that, although the patent system should not be amended to include plants, there would appear to be justification for "some separate system of rewards" for the discovery or development of new varieties. A registration system with provision for royalties was suggested as an alternative. However, the Royal Commission provided several reasons why it felt that neither patent protection nor a registration system for plant varieties would provide net benefits to Canada at that time.

While some of these reasons related to the fact that only asexually reproduced plants were under consideration, other reasons were more general. These included the fear that only a very small proportion of the varieties protected would be developed in Canada, causing a significant outward flow of royalties, and the fear that the economic benefits of new varieties developed as a result of the patent incentive would not outweigh the costs created by granting monopoly rights. The Report noted that the economic advantages of the patent system to a country such as Canada were a matter of great controversy, and believed that this would be even more true of a plant patent system. However, the Royal Commission recommended that if the Government believed that incentives were required to stimulate additional breeding, then a separate system of subsidies or grants would be preferable, being both direct and less discriminatory in application.[3] Inclusion in the existing patent system was not recommended.

The Goals and Objectives of Intellectual Property Law

The basic policy problem with which all intellectual property law[4] attempts to deal has been expressed as follows:

> ...the design of institutional arrangements that provide incentives to encourage experimentation, including the development of new products, new knowledge, new reputations and new ways of organizing activities without overly insulating these experiments from the ultimate test of survival...A wide variety of experimentation should be encouraged, investment should be channeled into promising varieties of experimentation and away from unpromising varieties, and the new knowledge that is acquired should be employed extensively. No known institutional arrangement can simultaneously maximize the degree to which each of these objectives is achieved.[5]

In addition, an important feature of the information production and dissemination goal of these property rights is their international application. No country is or can be self-sufficient in the production of information and technical knowledge. The existence of international conventions in intellectual property law provides access to knowledge developed elsewhere, while the need for these conventions also places constraints on the freedom of domestic policy-making. Both Canadian patent law and the proposed plant breeders' rights bill reflect this aspect of intellectual property law.

The objectives of property right law have been summarized as providing an incentive to invent, an incentive to innovate and an incentive to disclose. A limited monopoly right, such as a patent, is granted, allowing the inventor to earn a return on his invention. This is designed to increase the resources devoted to research and innovation. However, the question which has yet to be clearly answered is whether and how the patent system operates to achieve the results it is intended to achieve. The major benefit of a system of intellectual property rights has been identified as:

> "...the increase in the national product attributable to technological innovation which are generated by the system in the sense that they would not come into being without the patent incentive or would arise only at a later time."[6]

Such a benefit must be balanced against the costs of the system, including both direct administrative costs and indirect costs, either from the misallocation of resources or from the abuse of granted monopoly rights. The incentive to invent is achieved by allowing inventors to earn a higher return on their invention, increasing the price to users and generating lower sales and output than would occur if the invention were freely available. The impact of these restrictions on the efficient working of markets, both in the short- and long-run, should be taken into account in assessing the net benefit of intellectual property law.

Studies of the patent system have failed to provide evidence either to confirm or contradict the belief that the patent system has been an effective incentive. A thorough examination of the patent system in the U.S. concluded that:

> No economist, on the basis of present knowledge, could possibly state with certainty that the patent system, as it now operates, confers a net benefit or a net loss on society.[7]

However, this conclusion applied to the United States, and the author cautioned that "a different weight of argument might well suggest another conclusion" in the case of a small country[8] or a non-industrial country.

Both the costs and benefits of the patent system will be considered below as necessary for the evaluation of plant breeders' rights legislation. The effect of a new patent on market structure, pricing

and profits depends on whether it is for a new product or a cost-saving manufacturing process for an existing product. In most instances, the rights granted on a new variety can be considered a cost-saving (yield improvement) innovation, and they will be analyzed as this case.[9] Finally, there are a number of patent design measures that affect market structure and performance and the distribution of costs and benefits. Those measures, which are included in the proposed plant breeders' rights legislation, will be considered in this section as well.

The Benefits of a Patent System[10]

There are several benefits of a legal system of property rights to be considered in evaluating the net benefits of the system. The most important, and the one that is the key objective of a patent system, is the increase in the national product attributable to invention and innovation induced by the patent system. The benefit includes only inventions and innovations that occur as a result of the patent grant or occur much earlier than they would in the absence of a system of rights. Innovations that would have occurred in any case cannot be attributed as a benefit of the patent system. Unfortunately, this is very difficult to quantify or measure so that it has not been possible to estimate the benefit of additional research induced by the patent incentive in Canada. However, common sense indicates that the patent system can provide the greatest stimulus to research where it is not otherwise possible to appropriate the returns of unprotected innovation. Thus, when widespread and rapid imitation is easy, when the advantages of being first on the market with a new product are relatively small or when the profit potential of an innovation is relatively small, legal patent protection can stimulate research.[11] Patent protection allows an inventor to capture more of the profits of his invention. It seems reasonable to believe that these conditions apply to seed breeding so that breeders' rights have

the potential to provide an incremental stimulus to additional research. Without protection, varieties of all but hybrids can be readily copied, so that imitation would be easy. In addition, the profit potential of many new varieties is relatively low since the varieties provide characteristics needed in a very small area (unique soil or climate conditions) or are varieties of a crop that is not seeded with new pedigreed seed each year. The next major section, Section IV -- Plant Breeding Research, will examine current and expected levels of plant breeding research in Canada.

Additional patent benefits are obtained by the protection of Canadian inventions in foreign markets and the protection of foreign inventions used in the Canadian market through Canada's participation in international property rights conventions. The evaluation of these benefits is also difficult. On the one hand, the protection of Canadian inventions in other markets allows them to be sold in a larger market, potentially increasing both sales and royalty revenues. This might not be possible in the absence of a patent system in Canada since most countries grant protection on a national treatment basis only to other member countries of the Paris Convention.[12] On the other hand, approximately 95% of the patents granted in Canada are held by foreign companies and individuals, so that the benefits of Canada's membership in the international patent system accrue mostly to foreign patent holders in Canada. However, Canadians benefit from the use of patented products that otherwise might not be available. In addition, Canadians may benefit from the local use of a patent through increased employment. Critics point out that this disproportion indicates that the Canadian patent system may not work to encourage research in Canada. However, patent protection does make these inventions potentially available in Canada (although only 15% are actually utilized) when this might not otherwise be the case. It is not known if the proportion of patents utilized in Canada is the same as that in other countries.[13]. However, Canada is notable among Western industrial nations for the low proportion of patents

filed by residents.[14] While only about 5% of patents issued in Canada are issued to Canadian citizens and residents, comparable figures are 40% in the United Kingdom, 74% in the United States, 50% in West Germany, 77% in Japan and 30% in France.[15]

International trade benefits will be obtained if the plant breeders' rights legislation is adopted. The mixed evaluation of the patent system in Canada results from the fact that in technology development Canada is a "small" country in the world market. Therefore we tend to use technology developed elsewhere rather than the reverse. However, Canada is not as much a "small" country in terms of agricultural research as in industrial research. Canada has a significant and successful tradition of agricultural research, based on the public sector. Thus, the impact of breeders' rights in terms of its use by Canadian or foreign breeders is not likely to be the same as patents in the industrial sector.[16] For example, some Canadian varieties are now sold in foreign markets but, in general, no royalties can be collected on them. The magnitude of this potential benefit depends on the usefulness of Canadian varieties for a range of foreign markets and on the type of seed involved since royalties would only be collected on pedigreed seed of protected varieties. Thus, the preference of farmers in other countries for pedigreed or common seed will affect the collection of royalties on Canadian seed stocks. Similarly, the type of seed and how often new seed is planted will affect the collection of royalties in both domestic and foreign markets. Royalties will be collected on protected varieties of all hybrid seed since it is planted each year, because it does not reproduce true to type, and on most cross-fertilized seed, which is planted most years or alternative years, but would likely not be collected on a large proportion of plantings of self-fertilized crops.[17] For these crops, farmers often retain their own seed for planting in, perhaps, two years out of three. Therefore, it is relatively difficult at this point to estimate the size of the potential foreign market for Canadian varieties. An attempt was made

to estimate the percentage of seed imports and exports that are pedigreed for certain crops without success. Total seed import and export figures are often disputed and unreliable. This is even more true for data on pedigreed seed imports and exports. The data also do not clearly measure the trade in Canadian varieties since both the total seed imports and exports and pedigreed seed imports and exports would include more than Canadian varieties. Specifically, seed multiplied in Canada under the OECD Seed Scheme would be included, and it is unlikely that these varieties would be of Canadian origin. More reliable and disaggregated trade data are needed to indicate the share of all pedigreed seed in seed trade and the share of pedigreed seed of Canadian varieties in seed trade.

Some Canadian seed is sold in foreign markets despite the fact that our varieties cannot be protected in these markets, while in other cases Canadian varieties have been withheld from foreign markets. SeCan has withheld some Canadian varieties from the U.S. market to prevent resale into Canada of protected varieties. Similarly, some foreign varieties are believed to have been withheld from the Canadian market since they cannot be protected by a legal right, and the existing contractual arrangements are not felt to be sufficient protection. Other foreign varieties are sold in the Canadian market such as Summit, a private barley variety from England, and Opal, a private wheat variety from Germany.

Finally, it should be noted that the benefits of the patent system are not evenly distributed. The patent grant may be of greater advantage and a greater incentive to the small inventor rather than the large inventor.[18] This is because small inventors generally lack effective marketing channels and the rate of market penetration for their new products is generally slower, with realized profits correspondingly lower. However, the costs of using the patent system may be proportionately larger for small firms since the patent grant does not guarantee a return even with market success but merely provides a "licence to sue".[19] Substantial funds may be necessary to defend the patent and enforce the right to royalties.

The Costs of a Patent System

There are several costs associated with a system of legal or property rights that must be balanced against the benefits of the system. The most obvious are the direct administrative and enforcement costs incurred in using such a system. These include both the direct costs of administering the legislation, examining patent applications, and the legal costs of all participants, in applying for rights, in enforcing their rights and even in opposing the applications of others. The fees associated with obtaining and maintaining a patent grant, particularly when the patent is protected in more than one country, may be onerous for the small inventor. Further, the potential legal costs mentioned above may reduce the value of the system to the small inventor.

Less obvious, but perhaps more significant, are the costs incurred as a result of any misallocation of resources encouraged by the system and the costs of the abuse, by some, of the market power that the system creates. For an example of misallocation, it has been argued that patents can provide an incentive to over-invest in research, either because inventors are by nature risk-lovers[20] or because firms attempt to invent around patents held by competitors.[21]

The design of the patent incentive requires a careful balance since the misallocation of under-investment in research is often cited as a major reason for introducing and maintaining patent systems. However, many other factors can also affect innovative rivalry between firms.

Most discussions of resource misallocation and the patent system refer, not to the total amount of resources devoted to research but, to the impact of the patent grant on price and output. There is both a static and dynamic aspect to this. At a single point in time, patents can permit inventors to set a monopoly price, raising the

price above competitive levels by restricting output. In most cases,[22] although output is lower and price is higher than would be the case in a competitive market, consumers gain from the introduction of a patented product or production process. Patents permit holders to price as a monopolist, either by refusing to licence their invention or by setting royalties for licences that approximate the monopolist result.[23] However, the patent holder's monopoly power is limited by the availability of acceptable alternatives or substitutes for the patented product or process. This is reflected in the elasticity of demand for the product or process, with the greatest monopoly power occurring when there are few or no substitutes for the product and demand is very inelastic over a wide price range.[24]

The effect of patents on particular markets depends on whether they are for a new or improved product or a cost-saving production process for an existing product. It can be argued that variety protection should be analysed as a cost-saving improvement for an "old" product since in all cases but one, triticale, new varieties have been discovered for existing crops. In most cases a new variety will have a higher yield or greater disease and pest resistance than its predecessors, and can thus be considered a cost-saving (yield improvement) version of an old product. Another possibility is an improvement in the characteristics of the crop desired by consumers or processors that does not fundamentally alter the nature of the crop. McGee[25] examines the case of a manufacturing industry that is competitive both before and after the introduction of a cost-saving patent for an old product. Since the industry was and remains competitive, the demand for the final product faced by individual manufacturers is relatively elastic, and individual manufacturers have no influence over price. The maximum unit royalty that can be charged by the patent holder is approximately equal to the unit cost savings associated with the innovation, since manufacturers can always use the unpatented techniques. In this case, the patent holder appears to

have little power to affect prices and output for the final product. In fact, prices for the final product are generally slightly lower than they were before the invention. If this analysis is applied to the seed industry, the patent holder is the firm or individual holding the breeders' right on a particular variety, the manufacturers are the seed growers and the final product is pedigreed seed. Although the price of the final product is not completely elastic since pedigreed seed for a particular crop is not a homogeneous product, the price of a specific variety will be limited by the number and price of substitute varieties. The ability of the breeder to control price will depend on the yield improvement provided by his variety in relation to alternate varieties on the market, both unprotected and protected varieties.

In addition, patents may be used to facilitate various anti-competitive practices.[26] These practices can include, by way of example, price discrimination, tied sales, resale price maintenance and price-fixing. In general, the Patent Act does not clearly distinguish between the legitimate rights of patent holders and the practices which would be considered abuses of their grant.[27] The exception is the conditions for compulsory licensing that include provisions related to the absence of local working (manufacture or use) in Canada when the patent is capable of being worked within Canada and three years have elapsed since the patent was granted. The compulsory licensing conditions in the Patent Act do not consider the public interest apart from the public interest in local working, so that licensing is generally not an effective means of dealing with monopoly abuses and restrictive marketing practices associated with the patent grant. Certain abuses of intellectual property rights may be handled under the Combines Investigation Act.[28]

Resource misallocation associated with the patent system can also have a dynamic impact as it is believed that firms can extend their market power through time, by holding a number of related patents or by

filing minor product improvement patents. Firms holding large and extensive patent portfolios can affect market structure during the term of their original patent grant and well beyond.[29]

Optimal Patent Design

The design of the patent system itself can determine the degree and nature of the incentive provided and its effectiveness. Some of the costs associated with the patent system can be minimized by measures that also maintain its incentive. The design of the patent system should also take into account the fact that the patent system is one of a number of alternative and complementary policies providing an incentive to research and innovation. The Economic Council of Canada has expressed this as follows:

> All of the principal forms of intellectual and industrial property have long been recognized to have such (significant social) costs, and good policy-making requires that these be taken into account along with the benefits. They should be borne in mind when deciding, firstly, whether a sector of the total information system stands in need of state-provided incentives, and secondly, if it does, what particular kinds of incentive would be most suitable.[30]

The first, and potentially most important, provisions are those for licensing. Compulsory licensing schemes may be designed in a number of ways. Generally, the compulsory licensing provisions may be invoked when a patent holder has not utilized his patent within the

country or has unreasonably restricted utilization of the patent by others.[31] A prospective licensee may apply to the Commissioner of Patents for a compulsory licence when he has been refused a voluntary licence by the patent holder. A compulsory licence may be granted when the patent holder has abused his rights in one or more of the ways specified in legislation. The burden of proof is on the applicant to show that a compulsory licence is warranted. However, these provisions have been used infrequently, and actual licences are rarer still. In Canada, between 1935 and April 24, 1975, there were 61 applications for compulsory licences under Section 67. Of these, only 10 were granted, 10 were refused and two were still pending while the remaining 39 had been abandoned or withdrawn.[32] The Commissioner of Patents specifies the royalty rate to be paid by the licensee to the patent holder.

The compulsory licensing provisions have been used infrequently for a number of reasons. In the first instance, the legal costs of applying for and obtaining a compulsory licence are substantial. The average time to resolution for an application is two years, and licences may not be issued for three years after the Canadian patent is granted; the economic value of a licence may be reduced by the time it is obtained. Inventions that would justify the legal cost of applying for a compulsory licence would also be too significant for the patent holder not to utilize directly or through voluntary licensing. Costs for the applicant are substntial since he bears the burden of proof and it is often difficult to obtain sufficient acceptable evidence that one of the abuses necessary to obtain the licence has occurred. Finally, the existence of compulsory licensing may encourage voluntary licensing so that both parties may avoid a costly legal battle. This "deterrent" effect works only if the prospective licensee can demonstrate both that he is serious about applying for a licence and would be reasonably certain of success.

Liberalized licensing provisions have been available since 1969 for drug patents under Section 41 of the Patent Act.[33] For food and drug products, the burden of proof is reversed as the Commissioner of Patents is obliged to grant a licence unless there is good reason not to do so. Royalties are set by the Commissioner with "regard to the desirability of making the food (or medicine) available to the public at the lowest possible price consistent with giving the inventor due reward for the research leading to the invention (and other factors as may be prescribed).[34] The frequency with which this provision has been used, and used successfully, is in marked contrast to that for compulsory licensing under Section 67.[35] The results for general compulsory licensing and for more liberal licensing of pharmaceuticals are similar in the United Kingdom where comparable provisions are in effect. Compulsory licensing is not a feature of the U.S. Patent Act, but is possible under the anti-trust laws and has been extensively employed.[36]

As Section II explained, the plant breeders' rights bill includes provisions for both compulsory licensing and automatic licensing. While these provisions are similar, in some ways, to the two forms of compulsory licensing in the Patent Act, they are not identical. It is useful to review these provisions again to highlight the comparisons and contrasts with the patent system. Analysis of the licensing schemes proposed in the Plant Breeders' Rights bill must consider all three possibilities. In addition to the two forms of licensing, which will be applicable on a species-by-species basis, the bill includes provisions that regulations may exempt certain species for a few years or for the entire period of protection from both licensing provisions.[37] This would provide the breeder with limited or total exclusivity.

The general compulsory licensing provisions of Section 25 of Bill C-32 will apply to all species not specifically designated for Section 26, automatic licensing. The objective of Section 25 and the principle

used to guide the Registrar of Plant Breeders' Rights is that a "plant variety is made available to the public at reasonable prices, that it is widely distributed, that it is maintained in quality and that there is reasonable remuneration for the holder of the plant breeders' right respecting the plant variety".[38] A prospective licensee may apply to the Registrar for a compulsory licence if he has been denied a voluntary licence by the holder of the right. The Registrar is obliged to grant the licence, setting terms including the royalty, unless there is good reason to refuse the application. The terms of the licence may be changed and the licence itself may be revoked or extended by the Registrar at any time. The legislation permits regulations exempting certain species or varieties of a species from the compulsory licensing provisions for a number of years or for the entire term of the breeders' right. This may be done, on the advice of the Advisory Committee, when it is required to provide the breeder with an adequate return on his breeding investment.

Under the automatic licensing provisions of Section 26, anyone will be granted a licence automatically for a variety of designated species. Species will be designated with the advice of the Advisory Committee. Licences may be revoked by the holder of the right for good cause.[39] For the case of automatic licensing, royalty rates would be set by agreement between the right-holder and the licensee.

The provisions for exclusivity, limited exclusivity, automatic and compulsory licensing allow species to be treated in a number of distinct ways. This is in contrast to patent legislation where separate rules apply only to food and pharmaceutical products. Tailoring the patent system for specific industries has been resisted since it is not considered a practical alternative.[40] This raises the question as to whether the range of alternatives described above should be pre-selected by designating species for each provision as is suggested in Bill C-32. There will likely be sufficient differences

(within species) of market and profit potential that specific varieties should be dealt with separately. For instance, most varieties of wheat could be expected to be widely used in the Prairies, while a variety of wheat for the Maritimes would have a much smaller market area in which to earn returns. While tailoring does minimize uncertainty concerning the rules of breeders' rights for both the right-holder and prospective licensees, it should be considered and used with caution. If species are to be designated for automatic licensing or exempted from either or both licensing provisions, it should be done sparingly and with care to ensure fairness to all, breeders, growers and producers alike.[41] The breeders' rights legislation, in practice, should not restrict markets and provide a more exclusive monopoly right than necessary to achieve the objective of promoting additional research. The marginal benefits of promoting more variety development must be balanced against the marginal costs of creating tighter monopoly markets.

Other measures that have been proposed include reducing the life of the patent and allowing patents to lapse if an annual renewal fee is not paid. The optimal life[42] of a patent depends on a number of factors. Research has indicated that the optimal patent life for process inventions is rarely more than 15 years, and is shorter as the demand for the end product is more price-sensitive (elastic) and as the cost-savings of the invention are larger.[43] Other research has shown that the optimal patent life is much shorter for minor process inventions if the supply of inventions is elastic (i.e. there are no barriers to entry in invention and the market for invention is competitive).[44] In fact, granting a longer than optimal patent life initially may create a monopoly in the invention market, which then requires a long patent life for subsequent inventions. A simulation of policy alternatives using a model of private research and development spending by British industry indicated that a lengthening of patent life did not significantly affect the amount of

research and development performed. Direct financial incentives, such as tax cuts and grants, had the greatest effect.[45] This indicates that shortening the life of the patent may not have a significant effect on the research performed.

An annual renewal fee reduces the profitable life of a patent or rights grant and encourages early abandonment of certain rights. Most countries require an annual renewal fee to maintain a patent right. However, Canada and the United States do not charge an annual or periodic renewal fee to keep a patent in good standing. By employing a graduated fee schedule with low renewal fees in the first years, increasing to higher fees in subsequent years, holders must reassess each year whether it is worth their while to maintain their right. In Germany where this scheme is used, the average patent life is eight years rather than the full eighteen year term, and only five percent of patents are held to term.[46] This scheme eliminates patent protection on inventions that are no longer being used or are only of minor economic value, allowing free access to anyone wishing to employ them.

The proposed term of breeders' rights is a maximum of eighteen years[47] from the issue of the certificate of registration of the right. This was selected to conform with the convention of the International Union for the Protection of New Varieties of Plants (UPOV). The UPOV Convention appears to be consistent with early retirement of rights, since renewal fees have led to abandonments in Europe.[48] A graduated fee schedule may be used in Canada for plant breeders' rights. Fees could be set by species and could vary over the term to encourage early abandonment of rights on varieties no longer extensively employed. Many varieties are only used in significant quantities for a few years.[49] This should also be done carefully to ensure that useful rights are not abandoned due to costs and fees.

The final feature of the patent system, which provides a remedy for abuse of the grant, is the power of the patent authority to revoke the patent. This may be done if the patent is not locally worked instead of granting a compulsory licence, although it has never been done in Canada.[50] Patents may also be revoked for non-payment of annual fees. The proposed breeders' rights legislation permits the Plant Breeders' Rights Office to revoke rights for a variety of reasons including failure to meet the obligations of a rights holder and failure to comply with the terms of a compulsory licence. These provisions in Section 27(2) of Bill C-32 could also be used to deal with the case of failure to comply with the terms of an automatic licence under Section 26.

Section II: - Footnotes

1. Ilsley Royal Commission on Patents, Copyright and Industrial Designs, Report on Patents of Invention, (Ottawa: Queen's Printer, 1960). More recently, the Working Paper on Patent Law Revision, (Ottawa: Consumer and Corporate Affairs, 1976), recommended that plant and animal varieties remain excluded from patent law (p. 182).

2. The breeders' right will require that a protected variety be available for use by others in developing subsequent new varieties, so that disclosure in the sense of allowing other inventors (breeders) access to the protected knowledge (variety) for further research is satisfied. However, disclosure has often been described as providing sufficient information to allow someone else to copy or duplicate the protected invention (Economic Council of Canada, Report on Intellectual and Industrial Property, (Ottawa: Information Canada, 1971), pp.38-39, and Consumer and Corporate Affairs, op. cit., pp. 40-42, 47-54). Clearly, this will not be the case with breeders' rights. For example, hybrids can not be copied unless one has access to the parent inbred lines.

3. This alternative and its effectiveness is considered below.

4. This term generally includes patents, copyrights, trademarks, and rights on industrial designs, as well as breeders' rights (also known as variety protection).

5. Harold Demsetz, "Information and Efficiency: Another Viewpoint", Journal of Law and Economics, 12:1, April 1969, p.20.

6. F. Machlup, "An Economic Review of the Patent System", Patent Studies, Study No. 15, Subcommittee on Patents, Trademarks and Copyrights of the Committee on the Judiciary, United States Senate, 85tn Congress, Second Session, 1958. Quoted in P.F. Hay, "Issues on Patent Research", paper presented at the 1977 Canadian Economics Association annual meeting, mimeo, p. 19.

7. Ibid.

8. Tnis refers to a small country in the sense of having a small market relative to the world market for particular goods. This qualification has been a major factor considered in recent evaluations of Canada's experience with patent law since Canada is a relatively small market for high technology goods in comparison to the United States, Europe and Japan.

9. The exception would be the development of a new crop such as triticale, or a variety that is significantly different from other varieties of that crop so that it may be used in new ways, and satisfies a different market than the original varieties of the crop. An example of this is rapeseed/canola.

10. This section draws heavily on F.M. Scherer, Industrial Market Structure and Economic Performance, (Chicago: Rand McNally College Publishing Co., 1980), Second Edition, Ch. 16, and P.F. Hay, "Issues in Patent Research", op. cit.

11. Scherer, op. cit., p. 447.

12. Economic Council, op. cit., p. 50 and Consumer and Corporate Affairs, op. cit., p. 63.

13. Since Canada and the U.S. do not charge an annual or periodic renewal fee to maintain a patent in good standing, it is argued that the number of patents is inflated with a large amount of "deadwood". In contrast, European patent systems are likely to contain fewer unworked patents since a renewal fee is charged.

14. Kerry Schott, Industrial Innovation in the United Kingdom, Canada and the United States, British-North American Committee, 1981, p. 19.

15. Loc. cit. and O.J. Firestone, Economic Implications of Patents, (Ottawa: University of Ottawa Press, 1971), p. 45.

16. Although Canada is a relatively large market for seed, it is not a large market for pedigreed seed, which is the type of seed covered by breeders' rights legislation. Both Europe and the United States use much more pedigreeed seed than Canada for two separate reasons - in Europe because as much higher proportion of seed is pedigreed and in the United States because of the larger total acreages involved. Given these factors, it is difficult to determine whether Canada will be a relatively large or small market for protected pedigreed seed. In addition, the pros and cons of membership in the international intellectual property rights system system for small or less developed countries (small or less developed in terms of technology development and use) is a matter of great controversy. See Edith Penrose, "International Patenting and the Less-Developed Countries", Economic Journal, No. 331, Vol. 83, September 1973, pp. 768-786. She concludes that, on balance, membership in the international system of property rights does provide net benefits to less-developed countries, and that possible costs, in terms of abuses of patent monopolies can be adequately dealt with by patent and anti-combines law, rather than by discarding the patent system itself.

17. As usual, there are exceptions to this generalization. Although soybeans are a self-fertilized crop, most seed planted is pedigreed so that royalties would be collected on seed sales.

18. Scherer, op. cit., p. 449.

19. A. Silberston, "The Patent System", in The Economics of Information and Knowledge, ed. by D. N. Lamberton, (Harmondsworth: Penguin, 1971), p. 229.

20. John S. McGee, "Patent Exploitation: Some Economic and Legal Problems", Journal of Law and Economics, 9, October 1966, p. 136.

21. Scherer, op. cit., p. 446.

22. Scherer (pp. 442-433) deals with the four cases of a patented new product, a patented production process in an industry operated by a monopolist, a substantially more efficient production process in a previously competitive industry and a marginally more efficient production process in a previously competitive industry. Only in the last case will consumers not benefit significantly during the term of the patent grant since the reduction in price with the marginally more efficient production process will be very small.

23. McGee, op. cit., pp. 134-162.

24. The classic case of this is patented prescription pharmaceuticals, for which demand is very inelastic over a large price range.

25. McGee, op. cit., pp. 143-144.

26. Silberston, op. cit., pp. 233-234, Scherer, op. cit., pp. 451-452. See also Warren G. Lavey, "Patents, copyrights, and trademarks as sources of market power in antitrust cases", Antitrust Bulletin, Vol. 27, No. 2, Summer 1982, pp. 433-455 and Richard J. Gilbert and David M.G. Newbery, "Preemptive Patenting and the Persistence of Monopoly", American Economic Review, Vol. 72, No. 3, June 1983, pp. 514-526.

27. R.S.C., Patent Act, Section 67(2). Compulsory licensing will be discussed in the next section.

28. R.S.C., Combines Investigation Act, Section 29. The interface between intellectual and industrial property, on the one hand, and competition policy, on the other, is a complex one and there is considerable controversy and confusion over the boundaries between the two areas of law. See John C. Osborne, "Industrial Property and Bill C-13", in ed. J.W. Rowley and W.T. Stanbury, Competition Policy in Canada: Stage II, Bill C-13, Institute for Research on Public Policy, 1978, Chapter 13.

29. Hay, op. cit., p. 28, and Scherer, op. cit., pp. 451-452.

30. Economic Council of Canada, op. cit., p. 35.

31. Compulsory licensing provisions are found in both the Patent Act, Sections 67-71 and the Combines Investigation Act, Section 29. The following discussion refers to the provisions of the Patent Act.

32. Consumer and Corporate Affairs, op. cit., p. 104.

33. The liberalized provisions extended licences to the importation of drugs. The previous food and drug licensing provisions had applied only to manufacture in Canada.

34. Patent Act, Section 41(3) and 41(4).

35. Between 1969 and 1979 the Commissioner of Patents considered 291 applications for compulsory licences to manufacture and import or to import alone under Sections 41(3) and 41(4) of the revised Patent Act. A total of 246 (84.5%) were granted, 3 were rejected, 15 withdrawn and the remaining 27 were pending. Royalty rates were set at 4% of the wholesale selling price by the Commissioner of Patents. From E.D. Ellis, "An Application of the Dominant Firm Model to the Canadian Diazepam Market", mimeo, 1979, p. 2. Even prior to 1969, the licensing of food and drug products under Sec. 41 occurred more frequently than licensing under Sec. 67.

36. Scherer, op. cit., p. 456.

37. The proposed legislation is exceptional as intellectual property policy in the degree to which it permits regulations to vary by species.

38. Bill C-32, Section 25(2).

39. Clause-by-Clause Explanation of the Plant Breeders' Rights Bill, (Bill C-32), Seed Division, p. 8.

40. Economic Council, op. cit., pp. 36-37.

41. It should also be noted that Section 44(1)(e) permits the Governor-in-Council to make regulations "establishing principles to be observed by the Registrar in disposing of applications for compulsory licences and, particularly, in complying with subsection 25(2)" and subsection 44(κ)(i) permits exemption of entire species from the licensing provisions.

42. The term of the patent grant should provide sufficient incentive to encourage the allocation of resources to innovation without inducing an over-investment in innovation, or creating costs greater than the benefits of additional innovation. On the point of over-investment, see McGee, op. cit., p. 136.

43. Scherer, op. cit., p. 448.

44. M.K. Berkowitz and Y. Kotowitz, "Optimal Patent Design with Free Entry in the Innovation Market", Working Paper No. 7921, Institute for Policy Analysis, University of Toronto, September 1979.

45. Kerry Schott, op. cit., pp. 48-49 and "The Relations between Industrial Research and Development and Factor Demands", Economic Journal, 88: 349, March 1978, p. 100.

46. Scherer, op. cit., p. 455. This scheme is also used in Britain. Silbertston, op. cit.

47. Bill C-32, Section 20.

48. Boringer, "Co-operation of the UPOV Member States in the Technical Examination of Plant Varieties", Third International Colloquium on Plant Breeders' Rights, C.I.O.P.O.R.A., Hungary, April 28-29, 1977, pp. 54-55.

49. See for example Joseph G. Nagy and W.H. Furtan, "The Socio-Economic Costs and Revenues from Rapeseed Breeding in Canada", University of Saskatchewan, Dept. of Agricultural Economics, Technical Bulletin 77-1, May 1977, Table 5 for information on the use of different varieties of rapeseed from 1960 to 1976 in Western Canada. Similar results for other crops may be calculated using data available in the Prairie Grain Variety Survey for seven major Western crops.

50. Economic Council of Canada, op. cit., p. 66.

IV. PLANT BREEDING RESEARCH

The primary goal of Plant Breeders' Rights legislation is the stimulation of additional research in plant breeding. By permitting the collection of royalties on new varieties developed and sold both in Canada and abroad an incentive should be provided for additional breeding. It is also expected that the legislation will help finance breeding programs at Canadian universities through royalty collection on successful varieties.[1] In addition, the Federal Government has committed Agriculture Canada to maintain at least the current level of plant breeding research.[2] It has not been decided yet whether royalties will be collected on varieties, developed by Agriculture Canada, which are sold in the Canadian market and abroad.

The goal of stimulating additional breeding research is sometimes questioned on two grounds: whether or not additional breeding research is desirable and if so, whether additional research should be performed in the public or private sector. A great deal of evidence is available to answer at least the first question. Returns to plant breeding research are extremely high indicating that additional funds committed to plant breeding research would be justified. This subject will be discussed further below in the subsection, Rate of Return to Breeding Research and Beneficiaries of Agricultural Research. Some information on the mix of public and private research in other countries is also presented.

There are several aspects to consider in evaluating the potential effect of the proposed legislation on plant breeding research in Canada. The first is the effect the legislation may have on the level of private, university and government breeding research. Information on the current level and nature of plant breeding research in Canada

will be presented. Secondly, the experience of other countries with variety protection legislation can provide some assistance in predicting what is likely to happen in Canada.

The Current State of Plant Breeding Research in Canada

It is relatively difficult to determine accurately how much plant breeding research is being conducted, and whether it is being done by the public or private sector.

Agriculture Canada is responsible for roughly sixty percent (based on person-years) of plant breeding research in Canada.[3] It has been estimated that the Department allocated ninety-seven person-years directly to plant breeding in 1979.[4] This figure has remained relatively constant in recent years. However, successful breeding programs also require input from other scientists, such as plant physiologists and pathologists, as well as from technical support staff. Thus, it is not possible to estimate the total scientific and technical manpower committed to plant breeding research by the Department. Similarly, specific breeding costs cannot be accurately separated from crop production development research costs as a whole. However, some rough estimates have been made.[5] Plant breeding expenditures in 1979 were $15 million, an increase from $11 million in 1977-1978. Plant breeding expenditures appear to represent approximately one-third of the crop production development research budget.

Manpower and budgets have been roughly allocated according to the economic importance of the crop in terms of value and area. Other factors affecting allocation can include the difficulty of breeding a particular crop, and the need to breed varieties resistant to particular diseases, or varieties with an altered chemical or

nutritional composition for market acceptability or for new uses. The bulk of Agriculture Canada's breeding effort is found in wheat, oats, barley and corn. Crops of secondary priority are alfalfa, rye, flax, rapeseed, soybeans, potatoes and timothy.[6] Research is also conducted on many other crops, as well as on fruit trees and ornamentals. Information presented in Table C indicates whether breeding research is being conducted by the federal government, provincial governments, universities or private firms.

For a range of important agricultural crops, Agriculture Canada is by far the major source of varieties sold on the Canadian market. However, the market share and significance of Agriculture Canada's varieties in terms of both numbers and economic value appears to be greater than the relative size and importance of the Department in breeding research currently underway. This reflects both the importance which has been attached to public plant breeding in the past by the Department and the more recent entry of private firms into breeding research programs. Only one private firm, Stewart Seeds (now Ciba Geigy Seeds Ltd.), has a longstanding breeding program, with other firms starting breeding research only within the last seven years.[7] Tables D and E indicate that almost sixty-five percent of all wheat varieties (currently licensed), seventy-five percent of oat varieties, sixty-two percent of flax varieties and thirty-seven percent of rapeseed (and canola) varieties were developed by Agriculture Canada. Overall, the Department has developed more than fifty-five percent of the cereal, oilseed and other field crop varieties in use (excluding soybeans and sunflowers), thirty percent of major forage and grass crop varieties and fifty percent of special crop varieties.

Universities and the provinces are the second major source of new crop varieties. Approximately 47 plant breeders are employed at university research stations.[8] Universities across Canada are involved in plant breeding. Table C indicates the breeding research conducted by

TABLE C. PLANT BREEDING RESEARCH IN CANADA FOR MAJOR CROPS

Crop	Agriculture Canada	Provincial Government	University	Private[a] Firm
Cereals, Oilseeds & Other Field Seeds				
Wheat	Yes	Quebec Saskatchewan	Alberta Saskatchewan Manitoba Guelph	Yes
Barley	Yes (including hybrid research)	Alberta	Alberta Saskatchewan Manitoba Guelph Macdonald College	Yes
Oats	Yes	No	Yes	No
Rapeseed	Yes	No	Alberta Manitoba	Yes
Sunflower	Yes (inbreds)	No	Guelph	No
Soybeans	Yes	No	No	Yes (testing and adaptation)
Mustard	Yes	No	No	No
Flax	Yes	No	No	No
Buckwheat	Yes	No	No	No
Forage & Lawn Seed[b]				
Alfalfa	Yes	Quebec	Alberta Guelph	Yes
Alsike Clover	Yes	No	No	No
Red Clover	Yes	No	No	No

- continued -

TABLE C. PLANT BREEDING RESEARCH IN CANADA FOR MAJOR CROPS (continued)

Crop	Agriculture Canada	Provincial Government	University	Private Firm
White Clover	Yes	No	No	No
Sweet Clover	Yes	No	No	No
Bird's Foot Trefoil	Yes	No	Guelph Macdonald College	No
Cicer Milkvetch	Yes	No	No	No
Sainfoin	Yes	No	No	No
Timothy	Yes	No	No	Yes
Bromegrass	Yes	No	No	No
Reed Canary Grass	Yes	No	No	No
Orchardgrass	Yes	No	No	No
Creeping Red Fescue	Yes	No	No	No
Other grasses (other than lawn grass)	Yes	No	No	No
Corn	Yes (inbreds some hybrids)	No	Guelph Manitoba	(Hybrids, some inbreds)[c]
Special Crops				
Tobacco	Yes	No	No	No
Field Beans	Yes	No	Guelph	Yes
Field Peas	Yes	No	Saskatchewan	No
Lentils	Yes	No	Saskatchewan	No
Faba Beans	Yes	No	Manitoba Saskatchewan	Yes

- continued -

TABLE C. PLANT BREEDING RESEARCH IN CANADA FOR MAJOR CROPS (continued)

Crop	Agriculture Canada	Provincial Government	University	Private Firm
Garden & Vegetable[b]				
Tomatoes	Yes	Ontario	Manitoba British Columbia	Yes Unknown
Rutabagas	Yes	No	Guelph	No
Broccoli	Yes	No	No	No
Cabbage	Yes	No	No	No
Cauliflower	Yes	No	No	No
Cucumber	Yes	No	No	No
Sweet Corn	Yes	Ontario	No	No
Peppers	Yes	Ontario	No	No
Asparagus	Yes (contract research)	No	Guelph	No
Cantaloupe	Yes	No	No	No
Potatoes	Yes			

[a]The names of private firms conducting breeding research have not been identified here by crop. Private firms conducting breeding research are generally members of the Commercial Plant Breeders committee of the Canadian Seed Trade Association. Members have included Ciba-Geigy Seeds Ltd., Pioneer Hi-Bred Ltd., Maple Leaf Mills Ltd. (now Otto Pick and Sons Seeds), Saskatchewan Wheat Pool, King Grain Limited, Pfizer Chemicals and Genetics Ltd. (now Dekalb), W.G. Thompson and Sons Limited, United Co-operatives, Dekalb Canada Limited, National-N.K. Seeds Ltd., and Cargill Grain Co. Limited.

[b]Breeders of forage crops or garden and vegetable crops generally work on more than one crop in the group.

[c]Private firms conducting research into the development of hybrid corn varieties include Ciba-Geigy Seeds Ltd., Maple Leaf Mills Ltd., King Grain Ltd., Pfizer Chemicals and Genetics Ltd., W.G. Thompson and Sons Ltd., Otto Pick and Sons Seeds Ltd., United Co-operatives of Ontario and National - N.K. Seeds Ltd. It is not known whether Pioneer Hibred Corn Co. Ltd. breeds varieties in Canada or serves the market exclusively through imported varieties. Dekalb Canada Ltd. imports the varieties it sells in Canada. It is believed that a number of firms are now starting to develop their own inbred lines in Canada. Cargill Grain Co. Ltd. has imported corn varieties to Canada until now. It has announced plans for a major hybrid corn research center near Woodstock, Ontario. (Globe and Mail, September 11, 1981, p. B6).

Sources: W.T. Bradnock, "The Breeding, Multiplication, Processing and Sale of Seed of Varieties for Canadian Agriculture, Who Does What", June 1981, mimeo; and Agriculture Canada, Research Branch, Progress in Research 1979, 1982.

TABLE D. ORIGIN OF CEREAL, GRAIN AND OILSEED VARIETIES LICENSED IN CANADA

Crop	Bred in Canada				Bred Outside Canada					Total
	Public	University	Private	Total	Public U.S.[a]	Private U.S.	Public other	Private other	Total	
Spring Wheat	17	2	0	19	2	0	1	0	3	22
Winter Wheat	6	1	1	8	5	0	0	2	7	15
Durum Wheat	6	2	0	8	0	0	0	0	0	8
Barley-2 row	7	3	1	11	1	1[b]	1	3	6	17
-6 row	15	12	1[c]	28	2	0	0	0	2	30
Total	22	15	2[c]	39	3	1[b]	1	3	8	47
Spring Oats	27	9	0	36	0	0	0	0	0	36
Rye	2	4	0	6	0	0	0	2	2	8
Rape	3	5	0	8	0	0	0	0	0	8
Flax	5	1	0	6	2	0	0	0	2	8
Sunflower	3	0	0	3	2	18	0	0	20	23
Soybean	4	[illegible]	6	11	8	22	0	0	30	41
Total	95	40	9[c]	144	22	41[b]	2	7	72	216
(Percent)	(44.0)	(18.5)	(4.2)	(66.7)	(10.2)	(19.0)	(0.9)	(3.2)	(33.3)	(100.0)

[a]Includes varieties bred by USDA and by universities.
[b]Includes one variety bred jointly by a private firm in the United States and the United Kingdom.
[c]Includes one variety bred jointly by a university and a private company in Canada.

Source: Data provided by Seed Division at December 31, 1983.

TABLE E. ORIGIN OF SELECTED FORAGE, GRASS AND OTHER CROP VARIETIES LICENSED IN CANADA

Crop	Bred in Canada				Bred Outside Canada					Total
	Public	University	Private	Total	Public U.S.[a]	Private U.S.	Public other	Private other	Total	
FORAGE AND LAWN										
Alfalfa	14	2	1	17	3	31	0	0	34	51
Bird's Foot Trefoil	1	3	0	4	3	0	0	0	3	7
Red Clover	5	2	0	7	2	3	0	2	7	14
Creeping Red Fescue	2	0	0	2	1	1	0	3	5	7
Timothy	5	2	1	8	2	2	0	3	7	15
Total	27	9	2	38	11	37	0	8	56	94
Percent[c]	(28.7)	(9.6)	(2.1)	(40.4)	(11.7)	(39.4)		(8.5)	(59.6)	(100.0)
Special Crops										
Bean, Field	6	3	3	12	3	0	1	0	4	16
Pea, Field	5	0	0	5	0	0	0	1	1	6
Total	11	3	3	17	3	0	1	1	5	22
Percent[c]	(50.0)	(13.6)	(13.6)	(77.3)	(13.6)		(4.5)	(4.5)	(22.7)	(100.0)
Other										
Potato	20	5	1	26	24	4	2	1	31	57
Corn, Hybrid Field	26[b]	0	121	147	0	238	0	9	247	394
Percent	(6.6)		(30.7)	(37.3)		(60.4)		(2.3)	(62.7)	(100.0)
TOTAL	84	17	127	228	38	279	3	19	339	567

[a]Includes varieties bred by USDA and by universities.
[b]All hybrid corn varieties are distributed in Canada by private companies. Varieties developed by Agriculure Canada are released to the private sector for distribution.
[c]Percentages sum across the rows of the table.

Source: Data provided by Seed Division at December 31, 1983.

universities for a range of crops. Some university research programs are funded by the federal government while others are financed by provincial ministries of agriculture or by special provincial funds.[9] It is not known to what extent research conducted at the universities is privately funded.

The third and smallest source of varieties bred and released in Canada is the private sector. Approximately a dozen firms have research programs in Canada, mostly developing hybrid corn varieties. Table C identifies the firms with research programs by crop. Fewer than twenty-five plant breeders are employed in the private sector. A major stimulus to research in the private sector has been matching federal grants authorized under the Industrial Research Assistance Program (IRAP) administered by the National Research Council. Approximately half the firms with breeding programs have received funds from IRAP. Research proposals received by IRAP are reviewed with the assistance of scientific liaison officers. In the case of plant breeding proposals, research scientists from Agriculture Canada serve as scientific liaison officers for both the initial review of a research proposal and for the assessment of progress that is required each year if further financing is requested. Approximately $1.4 million was allocated to various plant breeding projects in 1981/82 by IRAP. Firms receiving assistance include the Alberta Wheat Pool, Ciba-Geigy Seeds Ltd., Descent Seed Co. Ltd., King Grain Ltd., Maple Leaf Mills Ltd., Otto Pick and Sons Seeds Ltd., Saskatchewan Wheat Pool, Semico Quebec Inc., W.G. Thompson & Sons, and Agriseed. IRAP pays the salaries and associated costs of research staff while the firms pay for all other costs.

Research in the private sector has also received a significant subsidy through the work of Agriculture Canada, particularly through the release of inbred lines of corn developed in the Department's Research Branch. In addition, hybrid varieties of corn developed by

Agriculture Canada are released to the private sector for marketing and distribution. Most private breeding programs have started relatively recently, within the last five years. Although the expected passage of variety protection legislation in the United States stimulated the growth of private plant breeding before the legislation was in place, there is no direct evidence that this accounts for the recent growth of private plant breeding in Canada.

Research has also been affected by a change made in December 1973 to the Regulations under the Seeds Act. This change limited the use of variety names to pedigreed seed. It had the effect of permitting a breeder to control the multiplication and sale of certified pedigreed seed through contractual arrangements that would permit the collection of royalties for multiplication and sale. In addition to privately developed varieties, a number of university and foreign varieties have royalties collected on them in this way.[10] It is probable that all new varieties developed and marketed by private firms have a royalty incorporated in the price of pedigreed seed. This means that most new varieties are now released on a restricted basis, rather than being freely available to anyone interested in multiplying and selling the variety. However, the effectiveness of these contractual arrangements is limited beyond Canada's borders. Moreover, they have not been legally tested in Canada, although there appears to be no reason why they could not be enforced domestically through contract law.

Plant Breeders' Rights legislation has been introduced in order to give a legal basis to the collection of royalties on Canadian varieties at home and abroad and foreign varieties in Canada, with the hope that this will stimulate additional breeding beyond that triggered by the regulatory changes of 1973. Moreover, the safeguards described in Section III above protect the public interest from

certain restrictive practices that may be incorporated in private contractual arrangements. There are three additional advantages to moving to a formalized system of Plant Breeders' Rights from a system of private contractual arrangements. The exchange of germ plasm material may not be as unrestricted now as it would be with a separate system of defined property rights. A separate system of defined property rights is also recognized by member nations of UPOV, ensuring reciprocal treatment of Canadian varieties abroad. Finally, the contractual system can only be applied to crops covered by the Seeds Act and on the Seeds Variety Order since only these crops have restrictions placed on the use of variety names.

Variety Protection and Breeding Research in Other Countries

The experience of other countries with variety protection can provide some indication of what could happen to the nature and level of breeding research in Canada, although comparisons are restricted by the limited amount of well documented information. The examples of the United Kingdom and the United States are the most relevant to the Canadian situation. The European experience with variety protection may not be a reliable guide for Canada since private breeding predominated in a number of countries, such as West Germany, France and Holland, prior to the formal introduction of variety protection.[11]

In the United Kingdom, the introduction of variety protection in 1964 was followed by a substantial increase in private breeding.[12] Although private breeding had existed before, many new private firms entered the market by evaluating varieties imported from abroad, with breeding programs located in the United Kingdom following afterward.[13] Both public and private breeding expanded, partially as a result of funding from royalties collected on varieties sold

domestically and abroad. Royalties were and are collected on public varieties and the National Seed Development Organization, a State company, was set up to market publicly developed varieties. Royalties are collect on public varieties in the United Kingdom on the grounds that the public has a right to earn a return on their investment in public plant breeding facilities. Approximately ten to twelve private firms are now engaged in breeding research. Private sector breeding is particularly important for barley, which is the most important grain crop in the United Kingdom. This reflects the magnitude of the return expected from new barley varieties due to the size of the potential market for new varieties. Private breeding is most likely to occur in crops that are extensively grown or are expected to increase in importance.[14] Competition between public and private sector breeders is perceived to have been of benefit to both sectors.[15] The policy on public sector vegetable breeding was recently revised to stimulate closer collaboration between public and private sector breeders and to rationalize the breeding efforts of the two sectors in this area.[16] The benefits of breeding work stimulated in 1964 by the Plant Varieties and Seeds Act are now being realized since the development of a new variety can take up to 12 to 15 years from the initial cross to commercial release of a variety.[17,18]

In the United States, the Plant Variety Protection Act (PVPA) was passed in 1970. This Act granted protection to sexually reproduced plant species, with the exception of hybrid varieties, while the Plant Patent Act had protected asexually reproduced species, such as ornamental plants and fruit trees, since 1930.[19] State agricultural experiment stations have worked in co-operation with the Agricultural Research Service of the U.S. Department of Agriculture to breed, develop and release new plant varieties. In 1978, a survey was conducted to examine the effect of the legislation on the breeding effort of state experiment stations after seven years experience with

Plant Variety Protection.[20] State experiment stations generally operate in conjunction with university and college departments of plant and crop science. The survey results indicated that commercial companies predominate in the development of five field and forage crops (corn, sorghum, sugar beets, tobacco and cotton), while public institutions predominate in the development of all other field and forage crops. More than eighty percent of corn and sorghum varieties used in the U.S. were developed by private firms. Both of these crops are hybrids.

It was noted that, although firms often used publicly developed inbred lines, the "hybrids being merchandised represent combinations decided upon and produced by the commercial companies."[21] Private firms also produce the majority of sugarbeet, cotton and tobacco varieties used in the United States. Private research is also important for hybrid sunflower breeding. In addition, attempts have been made to develop hybrid barley and wheat varieties, although most research is now conducted on pure lines as a result of difficulties encountered in developing good hybrids. Soybeans although self-pollinated, have also been a major area of research for private breeders.[22,23]

Public institutions still produce the majority of varieties for all crops in total. Plant variety protection legislation has not reduced the breeding effort of public stations (primarily state university stations), nor was a reduction in research effort expected in the future.

The incentive for private research is proportional to the existing acreage of a crop and the trend in acreage. In addition, there is a clear trend toward greater private breeding of hybrid crops. In the words of a U.S. seed industry spokesman:

> "Certainly the profit motive has helped stimulate some of the current private efforts. Where hybrids are possible, as with sunflowers, corn, sorghum and maybe wheat, proprietary control of parent lines and repeated annual sales provide powerful incentives".[24]

Although some private firms had started breeding programs for self-pollinated crops since the introduction of variety protection, "there is still a question of the extent to which companies can make such programs economic and profitable".[25] Presumably this results from the fact that self-pollinated crops are very stable over several generations so that farmers can plant a large proportion of their crop with their own seed and do not purchase pedigreed seed (bearing royalties) each year. As noted above, this is not always the case. Although soybeans are self-pollinated, there is a significant degree of private breeding, especially in the United States, and farmers do tend to purchase new seed each year. Another factor which can influence the extent of private breeding for a crop is contract production for a firm that requires specific characteristics for harvesting, processing or for product quality. An example of this would be breeding of vegetable, barley or corn varieties to meet the needs of processors.

The research of State experiment stations had shifted in favour of basic research, such as germplasm development, and away from variety development work. However, it is expected that varieties for small markets, restricted in size by local environment conditions, or for minor crops would continue to be developed in the public sector by the U.S.D.A. and State experiment stations. In addition, there appears to be increasingly close co-operation between public and private breeders as private breeders recognize the benefits to them of the on-going work and results of research conducted by public institutions.[26]

More evidence has recently become available on the experience in the United States. The Federal Trade Commission examined the state of competition in four input industries including the seed industry. The author considered the seed industry since the introduction of variety protection legislation in 1970, using hybrid corn as a benchmark. The author concluded that although the character of the seed industry was changing, competition was not threatened by variety protection since entry barriers remain low, public varieties provide competition to private varieties, and farmers still have the option of planting their own seed. Even in the highly concentrated hybrid corn sector, intense competition between firms limited the anti-competitive potential.[27]

An article reviewing the proposed effects of variety protection in Australia examined the arguments of both opponents and proponents of the legislation, noting that evidence on the economic effects of variety protection was largely confined to the observations of non-economists. The author concludes that variety protection in Australia would have relatively little effect, disappointing the worst hopes and fears of both proponents and opponents of the legislation. He also cautioned that because of Australia's uniqueness, the experience of other countries would not necessarily be repeated there. In particular, all positive changes after the adoption of variety protection, such as new breeding programmes and increased research expenditures should not be solely attributed to variety protection since these were caused by a range of factors.[28]

The experience of other countries with variety protection is roughly similar to that of the United Kingdom and the United States in that although there appears to be both co-operation and competition[29] between public and private breeders, there has also been a trend toward a division of labour between the two sectors, with public research tending more towards basic research with less emphasis on variety development. Research of this kind can indirectly contribute to private breeding by subsidizing the basic research that cannot earn

a return through royalties. The private sector concentrates on profit-oriented research, especially variety development, that has the potential to earn a return though royalties. There is a danger that this division of labour may lead to dissatisfaction among public breeders interested in variety development, and possibly their transfer to the private sector since the satisfaction of plant breeding is mainly derived from developing varieties and seeing them in use. In addition, if public sector research does become focused on basic research, it cannot be expected to be partially self-financing through royalties. Basic research does not have a visible or immediate return, so that it may be more vulnerable during cost-cutting exercises.

More evidence on the results of variety protection in other countries may be found in various surveys and questionnaires that have been sent to UPOV members. However, these surveys are limited in that they reflect, in most cases, the judgement and opinions of individuals. Little hard economic evidence from ex post analysis of the legislation is available. Moreover, accurate benchmarks of the structure and performance of plant breeding and the seed distribution industry before the introduction of plant breeders' rights are lacking, and analysis is needed to distinguish between the effects of plant breeders' rights and the results of other factors.

Breeding Costs in Other Countries

There is relatively little evidence available from other countries on the cost of breeding and developing a new variety. Research costs should also include the costs of unsuccessful varieties developed in conjunction with the successful variety, and development costs include the costs of bringing the new variety to market through testing and licensing. The length of time it takes to develop a new varietey also affects breeding costs.

The time involved is a function of both technical and institutional constraints. Research on plants that grow and mature rapidly may progress more rapidly as well since the breeder can grow two or three generations a year. Alternatively, breeding for specific climatic and soil conditions precludes using another location so that breeding research progresses more slowly. At a later stage, seed multiplication may be done in different locations for two multiplications a year. Institutional requirements for testing and licensing can account for three to four years of the total period. Multiplication of commercial amounts of seed from the breeder's stocks generally takes two to three years as well. Some of these activities may occur concurrently if it is apparent that the variety has merit and will be licensed.

Research costs spread over approximately twelve years can accumulate to over 3.0 million dollars, with estimates ranging from 1.5 to 3.0 million dollars for staple crops.[30] The difficulty of determining breeding costs and whether returns are adequate is highlighted by the findings of a consultant's report in Britain which concluded that it was not possible to determine whether the rewards of successful breeders under variety protection were either too high or too low.[31] An indication of the distribution of breeding costs is available from Britain where an index of breeding costs is used as a basis for setting royalty rates. The two major cost components, for a sample of public and private research facilities, representing an average approximately 35-40 percent of costs, were salaries for scientific staff and other costs, which included energy, maintenance and land rentals. Support staff salaries averaged approximately twenty-five percent of breeding costs.[32] It should be noted that breeding costs were obtained in rounded figures and the distribution of costs varied widely between the five stations in the sample.

The cost of breeding and developing a new variety will be increased as a result of the proposed legislation. Breeders opting to protect their varieties, and it is assumed that most will do so as the legislation is extended to new crops, will be required to show that the new variety is distinct, stable and homogeneous.[33] In addition, the breeder will be required to ensure that adequate seed is available to satisfy the market.[34] It is expected that, in general, a breeder will maintain sufficient seed stocks or will commercially release a variety since he can earn a royalty through seed sales. Finally there will be administrative fees to obtain a breeders' rights, annual fees to maintain the right and the possibility of legal fees for obtaining and enforcing those rights. While these costs may be seen as a small investment to protect the larger investment of the breeding and development costs, they may be a deterrent to small firms. Conversely they may encourage breeding by small firms on the grounds that their major investment in breeding can be protected.

Rate of Return to Breeding Research and Beneficiaries of Agricultural Research

The goal of plant breeders' rights legislation is to increase both public and private plant breeding research. This goal implies that the current level of plant breeding research is below the optimal level, and that the introduction of this legislation will increase the total amount of research. In addition, it is believed that the legislation will increase the returns to private breeding, thereby encouraging additional private breeding. This section of the paper will examine the rate of return to breeding research from society's point of view, rather than from the perspective of private rates of return. Initially, two different approaches to measuring the rate of return of research will be presented. Results of studies of hybrid

corn (U.S.), canola/rapeseed (Canada), wheat (Canada), and barley (Canada), will be presented to indicate the rate of return and distribution of the benefits of plant breeding research.

Several methods have been used to estimate the returns to agricultural research. Most research has used either a benefit-cost approach to estimating returns or an internal rate of return calculation. Benefit-cost calculation give the present dollar value of the benefits associated with each dollar of cost, considering total social costs and benefits. A normal return on capital is accounted for as well. Internal rates of return calculate the average annual return earned over the investment period from the date investments are made.[35] Another methodology which has been used to calculate rates of return to agricultural research is the production function approach. The production function approach relates changes in agricultural output to changes in inputs, including research.

Research on the rate of return to agricultural breeding research has indicated consistently that public (social) returns to public research are very high.[36] This indicates that, relative to other investments with lower rates of return, there is an under-investment in plant breeding research, and that each additional dollar spent on plant breeding research would result in many more dollars of benefits to both consumers and producers.

Griliches conducted the initial research on the returns to new variety development for the case of hybrid corn in the American midwest.[37] Using conservative assumptions in order to obtain a lower bound estimate, Griliches found that public funds spent on hybrid corn research in the United States up to 1955 had a return of 700 percent per year. He noted that the development of hybrid corn was a major technological breakthrough, so that its return would be much higher

than that for research and development expenditures as a whole. His study showed the divergence between private and social returns, since most of the benefits of hybrid corn research were captured by consumers rather than by the seed industry or by corn producers. He calculated internal rates of return for hybrid corn to be in the range of 35-40 percent.

More recent work has been done for three crops in Canada which have received extensive public support for new variety development. Nagy and Furtan[38] have investigated the returns to rapeseed breeding and the distribution of the benefits. Their research indicated that Canadians tend to under-invest rather than over-invest in agricultural research, including public agricultural research. Their estimate of the benefit-cost ratio for rapeseed breeding was 17.64. This may be interpreted to mean that each dollar invested in breeding research to improve yields (their study did not examine improvements in oil and meal quality that were occurring at the same time) returned $17.64. They interpret this to mean that research funds could have been borrowed at an interest rate of 101 percent without incurring a loss. In addition, they estimated the distribution of benefits to rapeseed breeding, with the result that consumers received 53 percent of the total social benefits through lower prices and higher output while producers received 47 percent of the total social benefits.

Other research has[39] examined the social value of wheat breeding in Canada. Zentner and Peterson looked at the level and distribution of social benefits from public investments in wheat breeding over the period 1946 to 1979. They determined that the annual level of social benefits rose from $2.0 million in 1960 (1971 constant dollars) to $141.0 million in 1979 (1971 constant dollars). The average internal rate of return for wheat breeding was 34 percent. Thus each dollar invested in research earned $0.34 each year in perpetuity. The

marginal rate of return was 44 percent. This result implies that an additional dollar invested in further research would earn 44 percent each year in perpetuity. According to their estimates, producers received 62 percent of the total social benefits while consumers, both domestically and through exports, received 38 percent of the total social benefits. Zentner and Peterson believe that the continuing high marginal rates of return to wheat breeding research indicate that society would benefit from additional investments in research, although it is impossible to state how much additional investment would be optimal.

Finally, research expenditures on barley breeding in Canada have also been examined.[40] The impact of jointly funded research was considered for malt barley breeding research. The consumer and producer surpluses resulting from improved yield and quality characteristics were estimated. Under two different scenarios the public return to public breeding research is about 50% and to private breeding research about 74%. On the other side, the private return to public research funds is about 16% and on private funds about 33%. These figures are consistent with those of other studies and indicate an under-investment in malting barley research in the past. Marginal returns indicate the expected future value of research expenditures made now, and these were positive and significant in all cases. They estimated that each additional public dollar on barley research would generate thirteen dollars of public benefits.

Other studies examining major crops around the world have indicated similar high rates of return. These results suggest that additional investments in breeding research for most crops would provide positive and high social rates of return. The distribution of benefits suggest that both producers and consumers benefit so that both should contribute to funding breeding research.

Section IV - Footnotes

1. Royalties are already collected through contractual arrangements on a number of varieties developed by university research.

2. E.F. Whelan, Plant Breeders' Rights, Farm Letter No. 119, June 1980, and E.F.Whelan, The Government View of Breeder's Rights, Speech presented to the Eighth Annual Meeting of the Canada Grains Council, April 1977.

3. This estimate is based on the estimate of person-years devoted to plant breeding research by Agriculture Canada, the universities and by private companies. (Seed Division.) The sixty percent figure is probably low when research expenditures or the total commitment of other technical staff to breeding research is considered. In other words, the infrastructure of Agriculture Canada contributes to its plant breeding effort, while universities and private firms may lack a similar and substantial supporting infrastructure.

4. Seed Division. Figure supplied by Research Branch. There are more than ninety-seven plant breeders employed by the Department, however, only ninety-seven person years were allocated to research in 1979.

5. These rough estimates were provided by the Research Branch to the Seed Division.

6. Seed Division.

7. This is significant since it may take 10 to 12 years to develop a new variety so that there is a substantial lag between research "input" and variety "output".

8. It is assumed that this figure includes breeders working under provincial programs. The provincial research programs appear to be closely related to university breeding. Seed Division.

9. The funding of university research by either the federal or provincial governments raises the interesting legal question of who owns the varieties thus developed, and has the right to collect royalties on them. Currently, the universities collect royalties on varieties they release, and these funds are reinvested in further plant research. In Alberta, royalties belong to the breeder rather than to the university, so that it is not certain whether the funds are reinvested in research.

10. These include, by way of example, five barley varieties, bred by Canadian universities and one barley variety bred by a private firm in England. These are also varieties of oats, rapeseed, red clover and wheat which have private contractual arrangements for the collection of royalties. Seed Division.

11. Thomas Curren, "Plant Breeders' Rights Legislation for Canada", Research Branch, Library of Parliament, Ottawa, mimeo, Sept. 1979, p. 36.

12. The impact of variety protection on breeding effort should not be examined without considering the level of breeding effort and the sources of new varieties prior to variety protection. In the United Kingdom, before and after variety protection was introduced, most varieties on the market were of foreign origin. This fact should limit the direct application of the results of variety protection in the U.K. to the Canadian situation.

13. P.W. Murphy, "Plant Breeders' Rights and The Improvement of Plant Varieties", in The Use of Genetic Resources in the Plant Kingdom, UPOV, Geneva, 1981, p.31.

14. It should be noted that Canada may not follow this pattern since varieties developed for certain major crops such as bread wheat, malting barley and rapeseed are affected by grading standards for the final crop.

15. Loc. cit.

16. United Kingdom, National Seed Development Organization Ltd., Thirteenth Annual Report and Accounts, 1979/80, p. 12.

17. "Some Thoughts on Plant Breeder's Rights in the United Kingdom", Seed Trade News, April 23, 1980, pp. 23-31. A similar estimate of 12-15 years is found in Feeding the 500 Million, ASSINSEL, the International Association of Plant Breeders for the Protection of Plant Varieties, no date, p.11.

18. The development of plant breeding techniques using biotechnology may significantly shorten the time required for breeding and selection. Costs, however, could be increased for both capital equipment and skilled breeders.

19. Leo Donahue, "Plant Protection in the United States", Third International Colloquium on Plant Breeders' Rights, C.I.O.P.O.R.A., Hungary, April 28-29, 1977. Tubers are excluded from the Plant Patent Act, although they are reproduced asexually. It should be noted that hybrids are not protectable in the U.S. However, hybrids are "protected" by their manner of reproduction.

20. Editor's Forum, "Agricultural Experiment Stations and the Variety Protection Act", Crops and Soils Magazine, Part I, Feb. 1978, and Part II, March 1978.

21. Ibid., Part I, p. 5.

22. Robert R. Kalton, "Recent Developments in Private Plant Breeding", Seed Trade News, June 3, 1981.

23. Soybeans represent an interesting case, and apparently an exception, since a great deal of breeding is done in the private sector. Since soybeans are self-pollinating, normally one would expect most breeding to be done in the public sector, because farmers tend not to purchase new seed for planting every year so the market is small. The reverse is true with soybeans: farmers do tend to buy pedigreed seed for soybeans each year, and a great deal of the breeding research (in the U.S.) is done in the private sector. This result may be explained by a number of factors. It is expected that soybeans may become an important crop for private breeding in Canada as well, since companies have now started to test imported varieties for their suitability to Canadian growing conditions. Soybean acreages have increased rapidly in Ontario in the last ten years. With such a rapidly growing crop, many farmers are growing soybeans for the first time, or are increasing their acreage. They are more likely to follow the advice of their provincial seed committees in buying recommended varieties. Their purchasing habits are not likely to be as established and traditional for new and growing crops as they are for well established crops. In addition, for a cash crop, farmers tend to be more willing to make higher expenditures for purchased pedigreed seed, if higher yields and returns are evident. Finally, the fact that a number of soybean varieties

have originated in private sector may affect the degree of promotion and advertising for these varieties, and as a result, their degree of use. Although none of these hypotheses can be verified, the example of soybeans does demonstrate the danger of generalization in the seed industry, since the factors affecting seed breeding and seed purchasing conduct are complex, and can vary significantly between species.

24. Loc. cit.

25. Editor's Forum, Crops and Soils Magazine, Part I.

26. On the other hand, it is often feared that variety protection will lead to less rather than more co-operation between breeders. No firm evidence is available on this point.

27. Robert F. Leibenluft, Competition in Farm Inputs: An Examination of Four Industries, Office of Policy Planning, Federal Trade Commission, 1981. See also R.K. Perrin, K.A. Kunnings, L.A. Ihnen, Some Effects of the U.S. Plant Variety Protection Act of 1970, Economics Research Report No. 46, Dept. of Economics and Business, North Carolina State University, Raleigh, North Carolina, August 1983, for more recent information.

28. David Godden, "Plant Variety Rights in Australia: Some Economic Issues", Review of Marketing and Agricultural Economics, Vol. 50, No. 1, April 1982, pp. 51-95.

29. The exception to this is the Netherlands, where the public sector does not release varieties. "Plant Breeders' Rights", Agricultural Institute of Canada, mimeo, 1979, p. 11.

30. Feeding the 500 Million, p. 11.

31. Interim Report of Working Party on Cereal Royalties, October 1977, p. 6.

32. Ibid., p. 10.

33. Bill C-32, Section 4.

34. Bill C-32, Section 25.

35. Barry E. Prentice and George L. Brinkman, The Value of Agricultural Research in Ontario: Research Methodology, Data Sources, and Principal Findings, University of Guelph, School of Agricultural Economics and Extension Education, July 1982, p. 19.

36. Additional evidence on this may be found in Vernon W. Ruttan, Agricultural Research Policy, Minneapolis: University of Minnesota Press, 1982; and in Thomas M. Arndt, Dana G. Dalrymple and Vernon M. Ruttan, eds., Resource allocation and productivity in national and international agricultural research, Minneapolis: University of Minnesota Press, 1977.

37. Zvi Griliches, "Research Costs and Social Returns: Hybrid Corn and Related Innovations", Journal of Political Economy, 66, October 1958, pp. 419-431.

38. J.G. Nagy and W.H. Furtan, "Costs and Returns from Rapeseed Breeding in Canada", Canadian Research, Jan.-Feb. 1978, pp. 32-34; and "Economic Costs and Returns from Crop Development Research: The Case of Rapeseed Breeding in Canada", Canadian Journal of Agricultural Economics, 26(1), 1978, pp. 1-14; and "The Socio-Economic Costs and Returns from Rapeseed Breeding in Canada", University of Saskatchewan, Department of Agricultural Economics, Technical Bulletin 77-1, May 1977.

39. R.P. Zentner and W.L. Peterson, "The Social Value of Public Investment in Canadian Wheat Breeding Research", paper presented at the American Agricultural Economics Association meetings, Logan, Utah, August, 1982. For Wheat breeding see also Wolfgang M. Schultz, "The Economic Impact of Wheat Breeding in the Prairie Provinces", Canadian Journal of Agricultural Economics, Vol. 13, No. 2, 1965, pp. 12-26.

40. S.J. Gibney and W.H. Furtan, "Welfare Effects of New Crop Variety Licensing Regulations: The Case of Canadian Malting Barley", American Journal of Agricultural Economics, Vol. 65, No. 1, February 1983, pp. 142-147 and A. Ulrich, H. Furtan and A. Schmitz, "Public and Private Returns from Joint Venture Research in Agriculture: The Case of Malting Barley", mimeo, 1983.

V. RESEARCH AND DEVELOPMENT AND THE FIRM: ALTERNATIVE INCENTIVES AND FACTORS INFLUENCING THE RESEARCH DECISION

Many factors, other than a system of intellectual property rights, can influence the amount of research and development performed by firms, its success, and its eventual use through commercially successful innovations. Characteristics of the firm and its industry, as well as financial conditions and specific inducements influence the amount of research and development performed. This section[1] will briefly mention the effect of other policies and programs, such as direct subsidies and both general and targeted tax incentives, which are designed to encourage research. In addition, characteristics of the firm, such as size and ownership, and the potential for innovation, will be mentioned in relation to their impact on research.

The potential effectiveness of a patent system in encouraging additional research effort can be affected both by the characteristics of firms and their initial propensity to engage in research, and by the effect of alternative incentives. Industries differ in the degree of opportunity for commercially successful research, and the potential effectiveness of an intellectual property rights system depends on the degree of opportunity available. In addition, the effectiveness of different incentives may vary according to the characteristics of the technology and firms involved.

Alternative Incentives for Research and Development

A patent system or other intellectual property rights system is just one of a number of substitute and complementary policies that have been used by governments to promote research and innovation. The selection of a policy instrument or instruments depends both on the effectiveness of various policies and on the costs and benefits associated with their use. The choice is affected by total costs and

benefits and their distribution as well as by the perceptions of the costs and benefits of those affected.[2] Technical and political factors also influence the choice of policy instrument.

Research in the Private Sector

Policies other than intellectual property rights that attempt to promote additional research include tax incentives, direct or indirect subsidies, direct government involvement in research, as well as general improvements to the financial conditions of firms. The last is both a basic and most critical factor influencing the amount of research performed by firms. Increasing risk and uncertainty and a decline in overall economic performance have contributed to a general decline in the amount of research conducted during the last ten years in most Western industrial nations.[3] Specific policies to promote technological innovation often neglect the fact that the goal of innovation is the successful adoption and use of technology. This final step will only occur if there are opportunities for growth and expansion in the economy, and if the degree of uncertainty and risk associated with introducing a new product or process is acceptable to justify the new investment required. As Schott expresses this:

> This higher level of unpredictability coupled with falling profit expectations and return on capital is a major contributor to the decline in innovation in the industrial sector. ... Because investment and innovation are complementary it follows that the cost of new investment has a significant bearing on the level of innovation; high capital costs obviously impede the introduction of new processes and products.[4]

Schott's model of research expenditures by British firms indicates that the policy change with the greatest impact on research expenditures would be overall corporate tax cuts as opposed to increases in R&D deductions for corporate taxes and in allowances.[5] Similarly, in an examination of the determinants of research expenditures by a sample of Canadian manufacturing firms, Howe and McFetridge concluded that current sales and cash flow were two significant factors affecting the level of research spending,[6] reflecting both firm size and the amount of internal funding available to the firm.

Beyond general improvements to the economic environment and the cash position of firms, governments have attempted to increase research spending by direct grants and subsidies, by specific R&D tax breaks, by creating a demand for new technology (e.g. defence, aerospace) and by performing the basic research and even developmental work itself within government agencies and departments. Grants and subsidies, whether in matching funds or outright, are designed to supplement and increase the research spending of firms. However, these are subject to controversy. It is argued that they may be used only to finance marginal research projects, contributing to inefficiency, or that they may crowd-out or replace private spending.[7] The Howe and McFetridge study examined the response of subsidy recipients and found that in all cases (their sample covered three manufacturing industries and included both domestically-owned and foreign-owned firms) matching fund subsidies did not reduce the amount of R&D spending,[8] and in a few cases actually increased the level of private spending, although spending was not increased by an amount greater than the subsidy. However, for the most part, little is known about how or whether subsidies and tax incentives actually increased R&D expenditures, and at what cost. Additional research is needed on the cost-effectiveness of various subsidy and tax incentive programs.[9]

Despite these qualifications to the effectiveness of subsidy policies, there may be grounds for directly supporting research among smaller firms to compensate for a lack of capital or of access to capital. Schott reports that although large firms spend proportionately more of their sales revenues or assets on research than do small firms, the productivity (effectiveness) of research among small firms is greater.[10]

Another reason for supporting small firms that is particularly relevant to the seed industry is that many small firms lack the resources to commit themselves to a research program that might pay off in successful varieties only after a decade or more. Firms may need assistance in maintaining a research program until it can be self-supporting by sales of successful varieties. One form of assistance is the Industrial Research Assistance Program (IRAP) of the National Research Council.

Research in the Public Sector[11]

Direct government involvement is the final alternative, either through contract research or in-house research. Traditionally, in-house research has been the approach for seed variety development in Canada. This has been the case both because of the historical weakness of the private sector in this activity and because of the "public good" nature[12] of plant breeding activity.

Agricultural research is not a pure public good in a strict technical sense. A pure public good is one which, because it cannot be withheld from one individual without being withheld from all others, is supplied communally to all by the governments. The classic example of this is national defence. Many other goods, while they do not meet

the strict definition of a pure public good, are also supplied by the government rather than by the private sector. Examples of this are education, health care and agricultural research. These goods are known as quasi-public goods or as social or merit goods. They are provided by the government, or by a mix of the public and private sectors, since their supply, in terms of quantity or quality, would be inadequate if left to the private sector alone. For these types of goods, social benefits are greater than private benefits so that society as a whole has an interest in the adequate provision of these goods. As discussed earlier, the social returns from plant breeding are very high and are greater than the private returns that can be recaptured through sales. Private returns do not ensure the optimal provision of these goods in terms of social benefits and costs.[13]

Characteristics of the Firm and Industry Affecting Research Performance

Both firm and industry characteristics have been found to influence the amount of research and development performed by firms. The firm-level characteristics which have been identified as influences on research include the size of firm and the ownership of the firm. Similarly, the industry-level characteristic which has been argued to influence most strongly the amount of research and development performed is market structure. The influence of market structure on research and development performance can be considered both theoretically and empirically.

Each of these firm and industry characteristics will be considered briefly in this section.

Size of Firm

It has long been argued that larger firms will spend proportionately more on research and development than will smaller firms, and that they will, in general, be more successful in producing commercially usable research output. Two reasons why this might be so include scale economies in the production of research and larger and more effective incentives for research within larger firms.[14] The first of these refers to the substantial fixed and declining variable costs believed to be associated with conducting research in the firm. In contrast, there may also be distinct disadvantages of firm size. It is argued that there is a bias against truly pathbreaking research within large firms. Not only are large firms believed to be more conservative in their research projects, but also they are believed to be overly-organized and too bureaucratic for successful, innovative research to occur.

Empirical research has failed to decide conclusively between these two conflicting positions on the relative amount and success of research performed by large and small firms. Initial research indicated that increasing size was not necessarily associated with more than proportionate increases in research and development expenditures,[15,16] at least among the largest firms. In fact, the general result of most studies was that spending increased just proportionately or even less than proportionately with increases in firm size.[17]

More recent research has examined differences in the type of research performed by large and small firms. Some evidence[18] now shows that increasing size of firm is associated with a more than proportionate increase in spending on basic research, and with a less than proportionate increase in spending on research towards entirely new products and processes. These results are not contradictory since basic research is quite different from research directed towards new products and processes.

A related question concerns the effect of the size of firm on research output rather than research input. There are substantial difficulties in determining an adequate measure for research output. Patents have been used as a measure of research output, although there are well-known difficulties with this measure as a proxy for inventive output.[19]

Studies[20] have shown, in general, that research output follows a pattern similar to research input, that is, that it increases proportionately with firm size up to a certain threshold, and then rises less than proportionately among the largest firms.

The conclusion that may be drawn on the evidence to this point is that research spending increases absolutely but not relatively with increases in the size of the firm, and may even decrease slightly among the largest firms. In addition, the nature of the research performed by firms may be influenced by the size of firm.

Ownership of the Firm

The relationship between ownership of the firm and the amount of research and development performed is one that has been a matter of great controversy and debate. There are several questions which will be briefly considered in this section concerning the relationship between firm ownership and R&D performance. The first concerns the strength of the relationship between firm ownership and R&D performance, and the direction of causality between these two factors. Do foreign sales and foreign production influence the research intensity of the firm or does the research intensity of the firm affect the proportion of sales and production accounted for by foreign-owned subsidiaries? The second question concerns the factors influencing the multinational in its decision of where to locate research and development facilities. The third question is an

extension of the second as it considers the amount of research performed by foreign-owned subsidiaries in host economies, and the factors influencing this, from the perspective of the host country.

Economic research has indicated a clear association between the extent of multinational involvement of the firm and the research intensity of the firm. Both of these measures refer to the firm as a whole, not the firm in either its home or host economy alone. However, the causal relationship between the two is generally poorly understood.[21] On the one hand, research and development expertise developed in the home market may increase the firm's ability to successfully market products abroad. On the other hand, multinational involvement may enable the firm to carry out a more extensive research program both at home and abroad than it would otherwise be able to do. Most research up to this point has examined one or the other of these relationships, neglecting the other. One recent study, however, examined the simultaneity of these forces, finding that in a simultaneous equation model of research intensity and multinational involvement that, while the hypothesis that multinational involvement is an important determinant of R&D activity was supported, the reverse hypothesis was not supported.[22] The results also indicate that the degree of importance of multinational involvement as a determinant of R&D intensity has been substantially underestimated in most previous studies.

This result also supports those of another study which showed that if the ability of multinationals to transfer technology abroad were limited by trade restrictions, the research and development performed by these multinationals would decline.[23] This result, if it is supported by the work of subsequent studies, has important implications for the area of plant breeding. The amount of research and development performed by breeding firms may depend on the degree

of access these firms will have to the markets of other countries. The location of the R&D performed, in contrast to the amount performed, by multinational firms is a separate question.

Although studies have indicated that the total amount of research performed by multinationals is heavily influenced by the degree of their multinational involvement (sales and foreign production) and by their freedom to transfer technology abroad, another subject that is as important to both home and host countries is the location of the research performed. It is important for reasons of employment and for the development of a technological base in the private sector, since spin-off benefits to the rest of the economy are often associated with domestic research. Home countries often express concern about the "leakage" of technology through multinationals[24] while host countries fear a technological dependence on externally-generated technology.[25] In fact, there are conflicting influences on the firm affecting its decision to centralize or decentralize its research and to what extent. Unfortunately, there is very little accepted theory in this area.

The initial tendency of a multinational firm is to centralize its research at the parent firm in the home economy. This is so for a number of reasons.[26] Leakage of "knowhow" or "the risk of dissipation of its knowledge advantage" is a major factor. So too, is the existence, in many industries, of substantial economies of scale in research. The costs of conducting research may be such that firms can afford only one or two true research establishments. Agglomeration economies may also lead to centralized research. This may take two forms, either of beneficial spillovers between different projects conducted by the same company or of spillovers between several companies working in the same area (almost a synergistic effect similar to that found in the two well-known "Silicon" valleys), or

between a company and external research organizations such as universities. This last factor is important in industries which rely on a large proportion of basic research generated by the public sector and the universities. Plant breeding research in the private sector may be less centralized, rather than more centralized, if this effect is important since public breeding and university breeding programs are widely spread across Canada. Fear of duplication is another factor favouring centralized research.

In contrast, there are a number of factors which may encourage the multinational firm to decentralize research, at least to a certain extent. The cost of conducting R&D may be lower in the subsidiary firm. This could be the result of material, rental or labour cost differences, with labour being singled out as the most important cost factor for research activity. Studies of the decentralization of U.S. multinational firm research to other countries indicate that this has been an important factor in the past.[27] A second factor encouraging decentralized research may be the tax and incentive policies of host nations, which favour the establishment of research programs. On the other hand, policies of the home nation may partially or wholly counteract this result.

Another explanation may lie in the different types of research. Research conducted abroad may be product development and adaptation research, rather than basic research. Much of the foreign-based research of multinationals may be explained by this reason, research is conducted only to the point necessary to support foreign sales and the product adaptation needed for these markets. The following quote is indicative of how foreign R&D is viewed by multinational firms:

> ... overseas R&D activities tend to focus on development rather than research, on product and process improvements rather than on new products and processes, and on relatively short-term, technically safe work.[28]

In sum, there are a number of factors influencing the location of industrial research by multinational firms. Factors such as the relative cost of research inputs, the policies of home and host nations and even agglomeration economies with external research organizations such as universities can exert an influence in either direction. In most cases, industry-specific factors will affect the extent to which research is centralized in the parent firm. Some comments may therefore be made about the seed industry, but a definite conclusion on the balance of forces between centralization and decentralization is not possible on the basis of currently available data and experience. It is generally believed that the economies of scale in plant breeding have not been large. The cost disadvantages of operating many relatively small plant breeding programs is believed to be small or offset by the advantages of location-specific breeding results. This is at least true with conventional breeding technology. Thus, just as public plant breeding research is not centralized within Canada or within the United States, one could expect that private plant breeding research within the firm would not be centralized in one location. Although the breeding of one crop may be located in just one or two locations by a firm, this will likely not be the case with crops that are very sensitive to local climate and soil situations. This factor will be most important in encouraging plant breeding research in Canda.

Agglomeration economies may be expected to operate in the same way. While it is true that firm research activities may tend to congregate around external sources of research such as universities and public breeding stations, this will not necessarily lead to centralization. There are many federal and provincial breeding stations and university breeding programs all across the country to provide support to private breeding programs.

In the previous section the factors affecting the decision of the multinational to centralize or decentralize research were considered, and in the context of conventional breeding technology[29] in the seed industry, there appeared to be strong forces favouring decentralization by the multinational firm. However, the third question posed at the beginning of this section concerning the location of multinational research and development from the perspective of the host country, and the host country factors affecting R&D location must be considered as well.

Although relatively little research has been conducted on this question, most of the published research does use Canadian data. A study of the determinants of R&D expenditures by Canadian and foreign-owned firms revealed that while Canadian-owned firms were quite sensitive to the domestic financial environment and to government incentives for R&D spending, foreign-owned firms were not sensitive to these factors.[30] Domestic conditions and policies are generally less effective in influencing the R&D decisions of foreign-owned firms. This reflects the fact that most R&D decisions by foreign-owned firms are made within a global-firm context rather than in a national-branch plant context. As a result, branch plants often tend to do less research (as a percentage of sales revenue) than do domestic firms in the same industry or their own parent firms. Despite the lower intensity of research in branch plants, research by foreign-owned subsidiaries still accounts for over fifty percent of industrial research in Canada, and a large percentage of industrial research in a number of other western economies.[31] Although this represents a large portion of Canadian industrial research and research in certain other economies, it represents only one-tenth of the research of the firms involved. This could be a relatively unstable situation for the economies of host nations and one that could easily change against their interests.

Industry Market Structure and Research Performance

As noted in the introduction to this section, the industry characteristic which has received the most attention in the consideration of research performance is market structure, both theoretically and empirically. The theoretical work that has been done on this issue may be divided into two categories: pure theoretical work which examines the relationship between research performance and idealized market structures such as perfect competition or perfect monopoly, and theoretical work on a more practical level done as a basis for empirical studies. The first will not be considered here[32] while the second will be presented as background for the empirical work considered in this section.

The empirical question which has been examined by many authors is how market structure affects both research effort and research performance. There are two elements to market structure that have been considered: concentration and barriers to entry. Concentration has been used as a proxy for rivalry in the development of hypotheses relating market structure and innovation. The hypothesis that active and potential rivalry in an industry promotes innovative activity is a concept that derives from the work of Schumpeter. Industry concentration measured by concentration ratios[33] is the most commonly used proxy of actual rivalry, although the limitations of this measure are well known. In particular, potential rivalry is perhaps equally important but it has not yet been possible to develop a measure for it.

There is very little consensus in the literature on the a priori influence of market structure on research performance other than a general agreement that perfect competition does not efficiently allocate resources for technical advance.[34]

The hypothesized relationships between market concentration and innovation have been explained by a number of factors. Monopoly is believed to encourage research and development spending since it is generally held that innovation is costly and risky, and that only firms with monopoly power will have sufficient resources and organizational slack to enable them to devote resources to research. On the other hand, it is argued that competitive pressures encourage other types of innovations, particularly cost-saving ones.[35] The first proposition should not be confused with the reverse, that the expectation (rather than the existence) of monopoly profits (through exclusive patent rights) encourages research. There is also an important distinction between product and process innovations regarding the effect of market structure. It is believed that firms in a more competitive industry will have a greater incentive to develop and use new production processes since output will expand further than in a monopoly situation with the same cost reducing production process, thereby increasing the profit potential of the process.[36]

In contrast, it is believed that product innovations will be encouraged by an oligopolistic market structure. There are two sets of forces at work in this case, a set of factors stimulating research and a set of factors affecting the opportunity or market room for successful product innovation. These factors act to balance the pace of research undertaken by oligopolists against the benefits of being the first to innovate successfully. Increased costs are associated with increasing the pace of research activity. The benefits to being the first firm in an industry to successfully innovate include the prospect of a longer period of time to tap the profit potential of the new product, and perhaps a more permanent profit and market advantage can result from being the first on the market.

The factors that can accelerate the pace of development (independently of the costs of acceleration) include the number of rival firms and the relative size of the potential innovator to the rest of the market. An increase in the number of firms, up to a point, will increase the pace of development. Similarly, firms with relatively small market shares relative to the leading firm in the industry will tend to innovate more quickly than the larger firms since the benefits to them of success are that much greater in terms of increased market share. These factors suggest that a loose oligopoly market structure is more favourable for promoting innovation than either a tight oligopoly or a monopoly.

Limiting the effect of these factors stimulating research will be the effect of factors influencing the "market room" of an innovator. The "market room" factors include "the size of the overall market profit potential, the number of actual and potential rivals vying to share that potential, the speed at which rivals are expected to react and imitate, the degree to which being first confers a permanent product differentiation advantage, and the magnitude of the anticipated R&D costs."[37] These factors determine the amount of profitable "market room" available for a successful innovator's new product.

These considerations imply that while monopoly and high levels of concentration provide organizational slack and ample market room for innovation, it is the lower levels of concentration found in loose oligopolies that provide the stimulus to innovation. Empirical results of these important conjectures have been mixed. Certainly, no clear, linear relationship has been found between market concentration and either research effort or research output.[38] One explanation of this result is differences in the technological opportunities open to different industries. Various studies have attempted to explore this with as yet inconclusive results. The factors discussed in the

paragraphs above suggest that not only technical opportunities, but also non-linearities affect the relationship between market structure and innovation.

The same conclusion is apparent in the literature discussing barriers to entry and the pace of innovation. Both very high and very low barriers to entry act as a disincentive to research, while moderate barriers to entry have been shown to provide a positive incentive to research, when all other factors including opportunity have been taken into account.[39] This is apparent particularly in industries where significant new entrants have introduced important technological innovations.

Summary

This section has briefly discussed the alternative policy incentives to research and development performance and the firm and industry characteristics which might be expected to affect research performance independently of the possibility of patent or breeders'rights protection. With respect to the substitute and complementary policies to patent policy discussed in the first section, few firm conclusions are possible. Just as detailed analyses of the patent system referred to in Section III have failed to conclusively support or deny the effectiveness and net positive benefits of the patent system, so too have studies of alternative policies, such as grants and tax incentives, failed to provide consistent and conclusive results. The one result that appears to be substantiated is that the financial environment of firms is important. Firms require adequate capital both to invest in research and to introduce the successful products of their innovative activity. The possibility of a financial reward after successful research may not be sufficient to encourage small firms to conduct research or to enable them to use the results since innovation requires investment.

Additional research has shown that although increased firm size is associated with increased R&D spending, spending may increase less than proportionately among the largest firms. Other work indicates that smaller firms may also use their R&D resources more effectively in some cases than the largest firms.

Multinational involvement is another factor that affects a firm's R&D performance. The ability to exploit freely their technical advances in a number of markets is a major influence on the size of R&D budgets in multinationals. The research performed by these firms may be more or less centralized with the factors in the case of the seed industry indicating some basis for relatively local, decentralized research, with current breeding technology. More advanced techniques based on biotechnology could change this result.

Finally, moderate levels of industry concentration and moderate barriers to entry provide the greatest stimulus to inventive activity, with higher and lower levels of concentration and barriers to entry reducing the incentive to devote resources to research.

The effects of alternative policies and firm and industry characteristics should be taken into account when the effects of plant breeders' rights legislation are considered, since the decision to innovate is affected by many factors, not just by the possibility of protection for the invention.

Section V - Footnotes

1. Although this study focuses on the economic implications of plant breeders' rights legislation, it was felt that mention should be made both of the alternative incentives used to encourage research and development by firms and of the characteristics of firms and industries that have been shown to influence the amount of research and development performed. Factors will be briefly raised, with extensive references provided in case further details are needed.

2. M.J. Trebilcock, D. Hartle, J.R.S. Prichard, D.N. Dewees, The Choice of Governing Instrument: Some Applications, Technical Report No. 12, Regulation Reference, Economic Council of Canada, July 1981, p. I-5.

3. Kerry Schott, Industrial Innovation in the United Kingdom, Canada, and the United States, British-North American Committee, 1981, pp.45-62.

4. Ibid., pp. 47-48.

5. Ibid., pp. 48-49.

6. J.D. Howe and D.G. McFetridge, "The Determinants of R&D Expenditures", Canadian Journal of Economics, IX: 1, February 1976, p.66. This result should be qualified for foreign-owned firms, and will be discussed further below.

7. Schott, op. cit., p. 55; Howe and McFetridge, op.cit., and D.G. McFetridge, Government Support of Scientific Research and Development: An Economic Analysis, (Toronto: University of Toronto Press, 1977) for the Ontario Economic Council, pp. 65-71.

8. In other words, subsidies did not serve simply to substitute for private funds that would have been invested in research by the firms, in the absence of any subsidy from the government.

9. Eileen L. Collins, "Tax Incentives for Innovation: Productivity Miracle or Media Hype?", Journal of Post-Keynesian Economics, IV:1, Fall 1981, p.68.

10. Schott, op. cit., p. 53

11. More on the nature of research in the public sector and on the differences between private and public sector research in agriculture may be found in Ulrich, Furtan and Schmitz, op. cit. and Gordon C. Rausser, Alain de Janvry, Andrew Schmitz and David Zilberman, "Principal Issues in the Evaluation of Public Research in Agriculture", Department of Agricultural And Resource Economics, Berkely, California Agricultural Experiment Station, University of California, Working Paper No. 86, 1980.

12. Musgrave, R.A. and Musgrave, Peggy B., Public Finance in Theory and Practice, (New York: McGraw Hill Book Co., 1976), Second Edition, Chapter 3, and Scherer, op. cit., p. 457.

13. Another reference in addition to those already cited for alternative R and D incentives and their effectiveness (Trebilcock et.al., Schott, Howe and McFetridge, McFetridge, Collins, Scherer), is: "The Pitfalls of Trying to Promote Innovation", The Economist, (June 26, 1982), pp. 95-98.

14. See F.M. Scherer, "Firm Size, Market Structure, Opportunity, and the Output of Patented Inventions", American Economic Review V. 55, December 1965, p. 1103. See also Scherer, op. cit., pp.413-414.

15. Research and development expenditures are normally examined as a proportion of sales revenue.

16. For this result see Edwin Mansfield, "Composition of R&D Expenditures: Relationship to Size of Firm, Concentration, and Innovative Output", Review of Economics and Statistics, LXIII:4, Nov. 1981, p.610.

17. Scherer, op. cit., pp.418-420.

18. Mansfield, E., op. cit., pp. 610-615.

19. M.I. Kamien and Nancy L. Schwartz, "Market Structure and Innovation: A Survey", Journal of Economic Literature, 13(1), March 1975, pp. 4-5.

20. Scherer, op. cit., p. 420. For another study on the subject of firm size and R and D performance see J.D. Howe and D. G. McFetridge, op. cit., pp. 57-71.

21. Mark Hirschey, "R&D Intensity and Multinational Involvement", Economics Letters, 7, 1981, pp.87-93; and Neil Hood and Stephen Young, The Economics of Multinational Enterprise, (Longman: New York, 1979), pp. 115-119.

22. Hirschey, op. cit., p. 92.

23. Edwin Mansfield, Anthony Romeo and Samuel Wagner, "Foreign Trade and U.S. Research and Development", Review of Economics and Statistics, 61, February 1979, pp.49-57.

24. See for example, Edwin Mansfield and Anthony Romeo, "Technology Transfer to Overseas Subsidiaries by U.S. - Based Firms", Quarterly Journal of Economics, 95(4), Dec. 1980, pp.737-750.

25. For this view see, Alan M. Rugman, "Research and Development by Multinational and Domestic Firms in Canada", Canadian Public Policy, 7(4), Autumn 1981, pp.604-616. Much of the work of the Science Council of Canada also reflects this view.

26. For a summary of the reasons favouring research centralization see Rugman, op. cit., pp. 606-607; and Sanjaya Lall, "The International Allocation of Research Activity by U.S. Multinationals", Oxford Bulletin of Economics and Statistics, 41:4, Nov. 1979, pp.313-331.

27. Edwin Mansfield, David Teece, and Anthony Romeo, "Overseas Research and Development by U.S.-Based Firms", Economica, 46, May 1979, p. 192.

28. Ibid., p. 193.

29. It is not known how new breeding technologies will affect the cost structure of breeding research and the location of plant breeding activities.

30. Howe and McFetridge, op. cit., pp. 57-71.

31. Mansfield, Teece and Romeo, op. cit., p.194.

32. Major references to the theoretical debate on innovation and alternative market structures include Harold Demsetz, "Information and Efficiency: Another Viewpoint", Journal of Law and Economics, 12(1), April 1969, pp.1-21; and Sheng Cheng Hu, "On the Incentive to Invert: A Clarificatory Note", Journal of Law and Economics, 16(1), April 1973, pp.169-177. Another recent reference is Partha Dasgupta and Joseph Stiglitz, "Industrial Structure and the Nature of Innovative Activity", Economic Journal, 90, (June 1980), pp. 266-293.

33. A concentration ratio such as CR4 is the percentage of total industry sales (or assets or other measures) accounted for by the four largest enterprises in that industry.

34. Scherer, op. cit., p. 430; and Morton I. Kamien and Nancy L. Schwartz, "Market Structure and Innovation: A Survey", Journal of Economic Literature, 13(1), March 1975, p.2.

35. Scherer, op. cit., p. 424.

36. Ibid., p. 426.

37. Ibid., p. 429.

38. Kamien and Schwartz, op. cit.

39. Ibid., pp. 23-24; and Scherer, 437-438.

VI. CONCLUSIONS

There are several points to be made at the conclusion of this study of the potential impact of plant breeders' rights legislation. Some common themes underlie the observations presented in this section. One is to prefer, for both economic and practical reasons, rights legislation that is as unrestrictive as possible, given the objectives of the legislation. This will be explained further below, but briefly it implies that restrictions on the use and distribution of varieties be minimized as much as possible, preferring reasonably free distribution to exclusive rights. A related objective is to keep the legislation and its administration as open as possible, with the reasoning for different sets of regulations clear and known. The legislation proposed will create legal monopoly powers which previously did not exist, while limiting in some ways these powers and also limiting other practices now used in contracts. The legislation has the potential to change gradually the structure and performance of the Canadian seed industry. Finally, the legislation should be evaluated with its differential impact on large and small breeders and on domestic and foreign breeders kept in mind. The seven points discussed in this section concern (1) the flexibility of the proposed legislation, (2) the relationship between the administration, goals and effects of the Seeds Act and the proposed Plant Breeders' Rights legislation, (3) the composition and use of an Advisory Committee, (4) the frequency and nature of reviews of the effects of plant breeders' rights, (5) the use and purposes of royalties collected, (6) the differential impact of the legislation on large and small breeders, and (7) on foreign and domestic breeders. Each of these topics will be considered in this final section.

A. Flexible Application of the Proposed Legislation

A great deal of flexibility has been built in to the proposed Plant Breeders' Rights legislation. A gradual process for introducing the legislation has been envisaged, with the legislation applied successively to different species after specific regulations have been drafted. The regulations would cover the requirements for determining whether a variety of that species was eligible for protection using the characteristics of being distinct, uniform, stable and new. The characteristics on which distinctness would be judged require species-specific regulations. The regulations would also cover the conditions under which the breeder would be allowed to exercise his right, either exclusively (for the full term or a part of it), or subject to either compulsory or automatic licensing. Thus, there is, through regulation, considerable flexibility in how the legislation may be applied. This corresponds with the flexibility in intellectual property law discussed earlier as optimal patent design.

When a new intellectual property right is introduced, a monopoly right is created. This is true even in the case of plant breeders' rights where the introduction of rights includes licensing safeguards that are missing from the current private contractual arrangements, which have developed recently since formal legal rights were not available. This monopoly right is being created for two specific reasons, to encourage plant breeding work in Canada that will develop plant varieties useful for agriculture both in Canada and abroad, and to allow Canada to participate in the international trade in protected varieties. These objectives should be kept in mind as this legislation is adopted and regulations are drafted.

Although our domestic policy-making is circumscribed by the need to conform with the Convention of the International Union for the Protection of New Varieties of Plants, the application of breeders' rights legislation in Canada can be relatively independent.

For crops where most varieties used are bred in Canada and are likely to continue to be bred in Canada, the degree of incentive offered should encourage breeding to be done in Canada for Canadian requirements. The effect of the incentive on the behaviour of and the returns to foreign breeders may be a secondary consideration since only a few varieties will be obtained from foreign sources for these crops. In contrast, for crops where a large number of varieties are bred elsewhere, since the crop is grown in a small area, the incentive provided should be just enough, but not more, to encourage the release of suitable foreign varieties on the Canadian market.[1] Royalties for foreign varieties entering Canada could be less without reducing the attractiveness of our market to foreign varieties.

If the protection given initially is insufficient to achieve the goals of the legislation, more generous protection through limited exclusivity, tougher compulsory licensing, or higher royalties could be offered. Once the legislation is in place it will be relatively easier to provide additional returns to breeders rather than the reverse.

Despite the need for and desirability of flexible application of breeders' rights legislation, investors and breeders will want relative certainty and simplicity in the legislation. It might be possible, for example, to have a "standard" regulation for major cereal crops that share common market characteristics. Similarly, special crops or forage and lawn seeds could be governed by similar sets of regulations, to simplify the administration of breeders' rights legislation.

B. Relationship between the Seeds Act and the Plant Breeders' Rights Bill

There are several important aspects to the relationship between the Seeds Act and the proposed plant breeders' rights legislation. In the first place, the registration (or licensing) provision of the Seeds Act, which is being strengthened, ensures that only varieties with merit are released on the Canadian market for species listed in the Seeds Variety Order. This, together with the list of varieties recommended by provincial seed committees, provide a form of buyer protection whereby farmers can plant varieties of known merit which are recommended for their area. The restrictions of the Seeds Act may form a barrier to entry for new varieties and perhaps even firms. It is possible that the effect of the entry restricting features of plant breeders' rights legislation will not significantly alter the ease of entry into the seed industry. The situation may be analogous to that of the pharmaceutical industry where fairly rigorous health and safety regulations now control what drugs may be sold in most national markets. This type of regulation appears, in some cases, to restrict entry and limit free access to the market as much as or more than patent or other intellectual property rights legislation,[2] by raising the cost of entry.

Since the Seeds Act already provides a barrier to entry for the species covered by the Seeds Variety Order, it is uncertain what the additional effect of Plant Breeders' Rights will be, and whether the effect will be different for species covered by the Seeds Variety Order in contrast to species not covered. In part it will be affected by the extent to which the Seeds Variety Order does act as a real and effective barrier to entry. It restricts the pedigreed seed sold to varieties that pass the test of being equal to or superior than existing varieties already listed in the Order. Thus, the entry of

new varieties for certain species is already restricted by a condition more stringent than the conditions of the breeders' rights legislation. It is not known whether this does in fact provide an effective limit, below that which would otherwise occur, to the number of varieties and breeding firms in the seed industry. However, many farmers do not plant pedigreed seed for each year so that there are alternative markets to provide commercial grades (non-pedigreed) seed throughout the seed industry that are unaffected by the Seeds Variety Order and would continue to be unaffected by breeders' rights legislation.

C. The Use and Composition of Advisory Committee

Section 42 of Bill C-32, the Plant Breeders' Right Act, enables the Minister to appoint an Advisory Committee. A single committee would be set up, in consultation with interested industry groups, from among farmers, seed growers, seed firms, the ornamental and nursery trades and breeders, to advise the Minister on the specific application of the powers of the Act. Although the advice of the committee will not be binding on the Minister, it is generally presumed that their advice will be both a useful input and a necessary prerequisite for broad support of the legislation, from both the seed industry and farmers.

The Advisory Committee, since it will be composed of groups from all sectors of the seed and nursery trades, could have the role of providing a forum for discussion and informing different sectors of the seed industry of the interests and positions of the others. Fair and reasonable compromises could be suggested and debated in the Advisory Committee, balancing the interests of both the producers and users of new plant varieties. At the least, well chosen representatives of consuming interests, such as farmers and firms in the ornamental, nursery and garden trade, who serve home gardeners as final consumers, could inform the groups they represent of the real benefits of breeders' rights.[3]

It is anticipated that the Advisory Committee will provide input and advice on matters concerning the order in which species will be protected by the legislation, whether a species should be subject to automatic or compulsory licensing, the conditions under which a specific variety of particular species may be granted a period of exclusivity on application by the breeder, and on the level of royalties.

The Advisory Committee or the Plant Breeders' Rights Office, or preferably both, could be provided with independent professional advice such as that of accountants or economists, when determining regulations that affect the degree of potential monopoly power granted to seed firms. These would include regulations determining which species should be subject to each licensing procedure and the factors affecting this choice, the conditions under which exclusivity would be considered and the appropriate level of royalties under a compulsory licence. Rate of return analyses of the alternative regulatory options in the legislation could be useful to both the Advisory Committee and the Plant Breeders' Rights Office. Providing advice on or regulating these matters requires an understanding, not only of the institutional aspects of the seed industry and the factors affecting breeding and trade, but also requires an understanding of the factors affecting the decision of the firm to invest in research and the returns to research. Experience elsewhere has shown that it will be difficult, if not impossible, to determine whether the returns to breeders are too high or too low.[4] The rate of return apparently earned by firms is affected by their price and advertising expenditure decisions. Earned profits can be easily dissipated by incorrect or inappropriate decisions on price and advertising expenditures. The economic decisions made by the Advisory Committee and the Plant Breeders' Rights Office are likely have a slow and imperceptible, but steady effect on the structure of the seed industry. This is particularly true when decisions are being made concerning the

appropriate level of royalties or selecting the appropriate licensing scheme to assure a fair return or "reasonable remuneration" to the breeder. For example, seed prices vary considerably from year to year as they are affected by unstable supply and demand factors and by the price of the crops they will produce. A royalty based on a percentage of the selling price of certified seed could thus also vary considerably between years. It is necessary to ensure that breeders are rewarded on the basis of the market success of their varieties. Professional advice might be useful to deal with these issues. It also appears useful to have someone familiar with the legal principles and precedents of patent and trademark law as a member of the Advisory Committee or available for consultation by the Committee. The administration of Plant Breeders' Rights can benefit from the lessons and experience of other forms of intellectual property rights and of variety protection in other countries.

D. Review of the Legislation

At present, Section 47 of Bill C-32 requires a report to Parliament ten years after the Plant Breeders' Rights Act is passed. The report is to cover both the effects of the legislation and an evaluation of whether or not it is in the public interest. The specific effects of the legislation that the report is required to examine include the following:

1) stimulation of breeding of varieties protected by breeders' right legislation;
2) improved access to foreign varieties;
3) the protection abroad of Canadian plant varieties through reciprocal protection;
4) the improvement in plant varieties; and
5) any other public advantage.

This report is in addition to the publication, through the Canada Gazette or later, the Plant Varieties Journal, of information related to the specific operation of the Act on applications, rights granted, variety names in use, rights that have been revoked, annulled or surrendered and other similar matters. The regular publishing of information on rights applied for and granted will provide operational information needed for compliance with the Act rather than information and analysis on the effects of the Act.

Formal public reporting of the effects of plant breeders' rights could be more frequent and wide-ranging than that now proposed. It is generally agreed that the effects of the bill, particularly the stimulation of additional breeding research, will be slight, especially at first.[5] The effects may be indirect and subtle, causing gradual shifts in industry structure and performance and increasing pressures on current institutions in the seed industry.[6]

Although the effects of the legislation may only appear over a longer period of time, such as the ten year period proposed, more frequent reviews are desirable for a number of reasons. Firstly, it would allow trends to be identified and monitored early. This would enable the effects of the legislation to be separated from other trends and from what would have occurred in any case.[7] In addition, administration of the Act could benefit as information on the results is obtained before the ten year period ends.

Secondly, base periods for comparison purposes would be developed through more regular reviews. Available data on the structure, conduct and performance of the Canadian seed industry are woefully inadequate and unreliable. Trade data useful for monitoring the effects of the legislation on international trade in pedigreed and commercial seed need to be improved. At the present time there are a number of sources of information on trade in seedstocks but very little of the data are consistent.

In addition, although it is realized that it will take a number of years before the effects of the legislation are fully felt, more frequent review may ease the concerns of critics. Many effects of the legislation are predictable now, even in cases where they will change over time. For example, it often takes ten to fifteen years to develop a new plant variety to the stage where it is ready for commercialization, so it may be a number of years before variety development induced by the protection of breeders' rights reaches the market. If variety protection is extended first to species that are expected to benefit most from the protection, then it must also be expected that there will be a smaller impact on breeding as protection is extended to other species. Similarly, when variety protection is first introduced it is expected to have a greater effect in allowing imports than in protecting exports so that the initial balance of trade and royalties in the seed sector will not be in Canada's favour. More frequent review can ensure that foreseen trends are occurring and, with proper explanations and analysis, reassure both critics and supporters of the legislation that it is bringing positive benefits to Canadian agriculture. While the net benefits of the legislation will be positive, some groups or interests may perceive themselves to be adversely affected.[8] Review could ease the potential controversy by identifying positive net benefits or the likelihood of future benefits to the agricultural sector as a whole.

The subject of reviews also raises the question as to whether it will even be possible to prepare an evaluation with clear certainty of the conclusions. In the United Kingdom, where variety protection legislation has been in place since 1964, it has not been possible, by the admission of the Controller of Plant Variety Rights, to determine on the basis of available information <u>beyond any doubt</u> whether the "plant breeders' rights system has achieved the objectives which it

set out to achieve." He goes on to say that, despite this, the system appears to have made a major contribution to agricultural productivity.[9] Although a report with definite conclusions may not be possible, qualitative reporting would be useful to monitor the effects of the legislation. Reporting similar to that of the Patent Office in the Annual Reports of Consumer and Corporate Affairs Canada would be sufficient.[10]

E. Seed Prices, Royalties, Research and Advertising

The level and uses of royalties and their impact on seed prices comprise a set of related issues that have caused concern among the critics of breeders' rights legislation. The level of royalties expected is about 5-10 percent of the price of certified seed.[11] Royalties may be levied as a percentage of the price of seed or as a fixed levy per quantity of seed sold (per tonne or kilogram). The form and level of royalty is not fixed by the Plant Breeders' Rights Act so it is not certain which method will be chosen. Other countries tend to have royalties charged per bag or tonne of seed rather than as a percentage of price. This appears to the fairest approach since the price of seed may vary considerably between years and between varieties depending on availability and demand, so that a royalty tied to the price of seed would cause breeders to gain profits or suffer lossses for reasons independent of the actual use of the variety.

The level of royalty that can be profitably charged depends in part on the price elasticity of pedigreed seed. While there are no studies[12] that examine the demand price elasticity of pedigreed seed, seed appears not to be very price inelastic for a number of reasons.[13] If seed demand is price elastic, royalties will probably be a small share of the price of seed and will not greatly affect the share of seed sold relative to seed saved. Seed of a specific variety may be expected to be demand price-elastic since

there are generally a number of choices open to the farmer. There are usually a sufficiently large number of reasonably close substitutes for a particular variety of seed, since other varieties could be chosen, commercial seed could be used, or the farmer's own seed could be planted as seed. The number and acceptability of substitutes will vary according to the crop and its intended use. Similarly, the period of time considered affects the elasticity of demand. Although farmers are locked in once they have made their crop and seed decisions in one year, their seeding decision in the following year is flexible, so the demand for seed is likely to be price elastic from year to year. On the other hand, seed could be relatively price inelastic since it comprises a small proportion of farm operating expenses, so that farmers tend not to be very price sensitive when purchasing seed. The question of the price elasticity of demand for seed can only be settled by empirical work. Theoretical reasoning appears to imply that seed is not demand price inelastic, and that it is likely demand price elastic or of unitary elasticity. Better data than that which currently exist for the prices and quantities sold of specific varieties of seed are needed for empirical work to test this reasoning about the price elasticity of seed.

The price elasticity of pedigreed seed is a major factor in determining the level of royalties and the choice of the breeder between exclusive production and licensing.[14] With greater price elasticity, the level of royalties or price premium paid to a protected variety will decrease, and there will be less of an incentive for the breeder to keep exclusive production of his variety. This subject requires further work to consider the effects of breeders' rights legislation on different sectors of the seed industry. Existing price and quantity data is inadequate for this kind of analysis.

There have been some fears expressed that royalty payments on seed will finance advertising and promotion rather than further breeding research. The examples used to justify and explain these concerns are advertising and promotional expenditures for hybrid corn, and the distribution of royalties on specific U.S. varieties that have been released on a restricted basis under the Plant Variety Protection Act.[15] Advertising is a relatively new issue[16] in the seed industry since most varieties in the past have been developed by public institutions rather than by private firms. Private varieties, particularly hybrid corn varieties, have been advertised and promoted in various ways by private firms. The methods have included standard media advertising, as well as demonstration fields grown by local dealers and farmers. Promotion has been less common for public varieties, although now public varieties released through SeCan are promoted and advertised using a levy on seed sales.

It is neither possible nor desirable for the government to control how royalties are used by private firms. For public varieties, one could maintain a distinction between research royalties and promotional levies so that it is clear to all why funds are being collected. This has been done by SeCan. To ensure that the bulk of private royalties are reinvested in further research rather than in excessive advertising, we should rely on incentives to invest in further research and on disincentives to excessive advertising. The best way to provide both of these is to maintain a strong public breeding program so that public varieties both complement and compete with private varieties, and to ensure that farmers are aware of the different information sources available to them for evaluation of alternative sources of seed. There may also be a role for increased promotion and information in the seed industry for both public and

private varieties since studies[17] have shown that farmers often do not use or are aware of all of the sources of information that are available to them.

Although the possibility for excessive and wasteful persuasive advertising rather than informative advertising does exist in the seed industry, there are a number of reasons why this is not likely to happen. In the first instance, selling seed is not like selling common consumer goods. Farmers purchasing seed are purchasing a producer good rather than a consumer good. Advertising intensity tends to be lower for producer goods since performance matters more than image. If farmers shop for and purchase seed and other inputs in an informed manner, relying on independent information and the established reputation of firms for quality, reliability and value, then the incentive for excessive or simply persuasive advertising by firms should be lessened. Secondly, there are already a number of independent sources of information for farmers. The pedigree system provides information on varietal purity while the standards of the Seeds Act provide information on seed quality, germination rate and the presence of weeds. Recommendations from provincial seed committees, universities and departments of agriculture on varieties provide another source of information for farmers. They should be encouraged to use each of these sources of information when making seed purchase decisions. Other studies have also raised, but discounted, the possibility of excessively increased advertising expenditures in the seed industry.[18]

False or misleading advertising is a different issue and it may be dealt with through the Combines Investigation Act. In addition, specific changes to the Seeds Act are proposed at this time to deal with the special characteristics of misleading advertising in the seed industry.

F. The Impact of Plant Breeders' Rights on Large and Small Breeders

It is important to maintain and encourage a varied distribution of sizes of seed firms. There are opportunities for both large, diversified and integrated seed firms as well as for smaller specialist firms. A wide range of firm sizes appears to be the best for encouraging productive research and development activity in an industry.[19] Small and medium-sized firms are often among the most vigorous innovators. Studies have shown that research and development expenditures (as a proportion of sales or revenues) increase with firm size, to a certain point and then level off or decline slightly.[20]

In applying and administering breeders' rights legislation, the differential effect of the legislation on large and small breeders should be considered. The proportionate level of risks, costs and returns are quite different for large and small firms. The reward that comes with commercial success and royalty collection occurs a number of years after the start of breeding work. Small firms, without financial support, may find it difficult or impossible to sustain a breeding program for the length of time or of the size[21] necessary to produce a successful variety. Thus, there is still a need for programs such as the Industrial Research Assistance Program (IRAP) and generous tax deductions or credits for research and development expenditures to assist small firms. Programs such as these are justified since small firms, while often relatively productive in their research, lack the resources necessary to sustain a long-term research project and to bring it to market successfully.

Small firms could join SeCan to improve their access to the marketing activity of federal and university varieties. For some, this may be the stepping-stone to developing their own research program. Small seed firms seriously interested in developing their own breeding programs could be encouraged by cooperation from federal, provincial

and university breeding stations. It has been the experience of other countries with variety protection that small firms have perhaps benefited most from the protection that rights have offered.[22]

Large firms also benefit from breeders' rights, although the legislation may not be quite as crucial to them in determining whether or not to invest in breeding research. Large firms often have adequate resources from other activities to sustain a breeding program until varieties can be commercially released. Even with the collection of royalties, not all varieties will recover their breeding costs through royalties. Recovering all breeding costs for a variety will be possible only if two conditions are met; that the variety is a commercial success because it is successful in use and that the breeder earns the return that is rightfully his as breeder of the variety. The first of these is unaffected by the existence of breeders' rights legislation while breeders' rights legislation does ensure the second, since others cannot profit from the variety without an arrangement with the breeder. It is possible that a portion of the returns of large firms may come from margins on production and distribution of the variety rather than from royalties alone. Small firms may lack a distribution system, so that their returns are based on royalties alone, rather than on both royalties and marketing margins.

In addition, the fees and legal costs of obtaining, maintaining and potentially defending breeders' rights can impose a proportionately heavier burden on a small firm than on a large firm. The benefits to society of new varieties with increased yields and pest resistance are such that a degree of subsidization to the administration of breeders' rights may be justified. If society as a whole will benefit from the legislation, perhaps society as a whole should share in its cost.

G. The Impact of Plant Breeders' Rights on Domestic and Foreign Breeders and on the Location of Research

One of the major benefits expected with the passage of breeders' rights legislation is improved access to foreign varieties that are currently withheld from the Canadian market. This has already adversely affected cereal crops, potatoes, alfalfa, peas, among others.[23] Access to foreign varieties will be improved since reciprocity with foreign rights systems will allow foreign varieties to be protected in Canada.[24] Certified seed of these varieties may be imported for sale or breeder seed multiplied here in Canada. Multiplication in Canada should be encouraged wherever the market for a variety in Canada is large enough to justify it, so that the economic benefits of multiplication activity will be realized by Canadian growers.

In addition to encouraging the release of foreign varieties in Canada, it is hoped that the legislation will induce foreign breeders to establish breeding programs in Canada to breed crops suited to Canadian requirements. The experience of other countries, particularly the United Kingdom and Europe, was that foreign seed firms started by evaluating varieties for their market, with local breeding programs developing afterwards. On foreign-owned breeding firms, the Agricultural Institute of Canada has expressed concern that "Canada can expect the private plant breeding effort in Canada to be largely dominated by multi-national firms whose global interests cannot always coincide with a Canadian focus".[25] Whether or not this is likely to occur depends on a number of factors. Firstly, a strong public plant breeding program should provide a standard against which private breeders and their varieties are judged. The registration (licensing) requirements of the Seeds Act also provide a standard against which all new varieties will be evaluated. Thus

foreign breeders will, for crops subject to the Seeds Variety Order, not be able to sell a variety in Canada unless it is equal or superior to varieties already on the Canadian market. It will be difficult to produce such superior varieties consistently without the existence of a specific breeding program for and in Canada. Other factors affecting the nature of breeding programs operated by foreign-owned firms are the scale economies involved in breeding programs and whether or not the foreign-owned firms perceive Canada to be a small market for seed. If Canada is seen to be a relatively large market for seed of specific crops, and if there are few cost disadvantages to maintaining small breeding establishments in Canada, then foreign-owned firms are likely to behave as Canadian-owned firms in breeding varieties in Canada specifically for our conditions. It is believed that with conventional breeding technology, there are few cost disadvantages to maintaining relatively small breeding establishments.

The location and ownership of research is important since it affects who pays for and who benefits from research. This issue is the major issue at the heart of the controversy over patent legislation in Canada[26] and the same principles are raised by breeders' rights legislation.

If the direct administrative and indirect structural costs of breeders' rights are incurred by Canada, it is desirable that research occur in Canada wherever possible so that royalties are paid into further research here, and the spin-off benefits are realized in Canada. These costs include the direct administrative and legal costs imposed by the legislation and the indirect costs imposed by higher seed prices and an increased potential for monopoly power and profits in the seed industry.

It is unlikely that the extreme imbalance of the Canadian patent system, with ninety-five percent of Canadian patents held by foreign individuals or companies and with a larger outflow than inflow of royalties, will occur with breeders' rights legislation. Canada is a relatively large market in terms of the volume of seed, at least in certain major crops, and the range of seed varieties required to suit our varied conditions. In contrast, for most areas of industrial innovation, Canada is a small market, one in which it is difficult to sustain a wide range of domestic research, so we often have to rely on imported technology. The potential strength and size of the Canadian seed market varies widely within different segments of the seed industry. This potential, in areas where Canadian breeding efforts are substantial and successful, should be encouraged. Canadian breeders will continue to specialize in crops that are important to Canadian agriculture and in crops in which we have a comparative advantage.

Section VI - Footnotes

1. To release a variety on the Canadian market, do breeders require the same, a higher or a lower return than they earn in their own home market and in other export markets? How does this return compare with the returns required by Canadian breeders of the same crop and of other crops? And how is the potential return to breeders affected by the regulatory provisions for automatic or compulsory licensing or for exclusivity that will be specified for each species?

2. See for example Peter Temin, "Technology, regulation, and market structure in the modern pharmaceutical industry", Bell Journal of Economics, 10:2, August 1979, pp. 429-446. See also Paul K. Gorecki, Regulating the Price of Prescription Drugs in Canada: Compulsory Licensing, Product Selection, and Government Reimbursement Programmes, Technical Report No. 8, Regulation Reference, Economic Council of Canada, May 1981, and Myron J. Gordon and David J. Fowler, The Drug Industry, Toronto: James Lorimer & Company, 1981.

3. This experience appeared to be the case for the Working Party on Cereal Royalties in the United Kingdom. Interim Report, October 1977, p.3. The importance of fairness, both the fact and appearance of, was expressed by the report of this Committee.

4. This point was made by the Working Party on Cereal Royalties (op. cit., p.6). A report prepared for the Working Party by an accounting firm indicated that "there was no clear case for saying that the rewards for successful Plant Breeders was either too high or too low".

5. Thomas Curren, "Plant Breeders' Rights Legislation for Canada", Library of Parliament, Ottawa, September 25, 1979, mimeo, pp. 27-28.

6. Agricultural Institute of Canada, op. cit., p.23; and Barry Wilson, Beyond the Harvest: Canadian Grain at the Crossroads, Saskatoon: Western Producer Prairie Books, 1981, p. 234.

7. It should be noted again that the benefits of plant breeders' right include only breeding research and its results that would not have occurred in the absence of breeders' rights. All breeding and new varieties developed cannot be attributed as benefits of the Act since a number of new varieties would have been developed in the absence of rights legislation.

8. Agricultural Institute of Canada, op. cit., p.23.

9. P.W. Murphy, "Plant Breeders' Rights and the Improvement of Plant Varieties", in The Use of Genetic Resources in the Plant Kingdom, UPOV, Geneva, 1981, p.32.

10. Additional reporting need not put a burden on rights holders. Information such as that in the Annual Report of Consumer and Corporate Affairs Canada for the Patent Office, or the patent data published in Statistics Canada's Annual Review of Science Statistics would be sufficient.

11. Seed Division.

12. Known to this author.

13. Demand is price elastic if for a given percentage change in price, the quantity sold will vary negatively by a larger percentage. This implies that a price reduction will lead to an increased expenditure on the product while a price increase will lead to a decreased expenditure on the product. Unitary elasticity implies that price changes are reflected by equal changes in expenditures on the product. On the other hand, demand is price inelastic if when price changes by a given percentage, quantity changes by a smaller relative amount.

14. Temin, op. cit., pp. 434-437. The extreme price inelasticity of pharmaceuticals led to quite a different pattern of industry organization and prices than would have occurred if pharmaceuticals were price elastic.

15. An example that could be cited for this point is Pikewheat, a variety released by the Missouri Seed Improvement Association for which royalties were allocated to advertising and promotion (75%) and to further research (25%).

16. See Annex A on "The Industrial Economics of Advertising" for a discussion of the two views of the role of advertising.

17. See for example the Seed Drill surveys in Manitoba, 1976 and in Alberta, 1980. See also Thomas F. Funk, A Description of Seed Corn Buying Behavior, Working Paper AE/73/13, School of Agricultural Economics and Extension Education, University of Guelph, August 1973.

18. Agricultural Institute of Canada, op. cit., p.21 and Curren, op. cit., p. 42.

19. It is generally agreed that invention and innovation is promoted by the existence of multiple sources of research and that specific firm sizes and market structures do not have a monopoly on encouraging research. See Scherer, op. cit., p. 418 and 432.

20. Scherer, op. cit., pp. 418-422 and Morton I. Kamien and Nancy L. Schwantz, "Market Structure and Innovation: A Survey", Journal of Economic Literature, 13:1, March 1975, pp. 15-18.

21. It seems reasonable to assume that the chance of breeding a successful variety generally increases with the scale of the breeding effort and that the developmental costs per variety produced decrease as certain fixed costs are spread over a larger breeding program. It is not known at what point there are diseconomies of scale in breeding work, although there is a limit to the range of different environments (soil and climate) that can be bred for at one location. It is also not known to what extent there are multi-establishment economies of scale to a firm operating several plant breeding establishments at different locations.

22. This has been the experience in the United States. U.S. Hearings before the Subcommittee on Department Investigations, Oversight and Research of the Committee on Agriculture, House of Representatives, Ninety-Sixth Congress, July 19, 1979, p. 13 and letter from B.M. Leese, Commissioner, Plant Variety Protection Office to W.T. Bradnock, August 8, 1979. Small firms have also benefited from protection in the United Kingdom.

23. Plant Breeders' Rights for Canada -- The Reasons for Legislation, p.4.

24. This will not necessarily apply to varieties which are currently protected elsewhere and are not sold in Canada. There are provisions in the Act (Section 8(1)(c)) and in the UPOV Convention that allow and require Canada to offer protection to varieties that have been sold elsewhere for not more than a specified period of time (usually four to six years). Clause-by-Clause Explanation of the Plant Breeders' Rights Bill, (Bill C-32), p. 3.

25. Agricultural Institute of Canada, op. cit., p. 12.

26. Economic Council of Canada, op. cit., pp. 49-50.

ANNEX A

THE INDUSTRIAL ECONOMICS OF ADVERTISING

Advertising is a difficult and controversial subject. It can have several functions at one time, informing and/or persuading consumers.[1] On the one hand, advertising can be seen as a means of informing consumers about the features and characteristics of a particular product, differentiating it from other, similar products. Information provided in this way may lead the consumer to learn about and adopt a new product more rapidly than he would otherwise. If the product is one such as an improved drug or a higher-yielding seed variety, there is a clear benefit to society in having the new product adopted quickly. It is also argued that rapid diffusion of new technology encourages further research and development. In addition, advertising can serve to differentiate branded goods and give consumers information about product quality and reliability which is important for encouraging repeat sales and sales of other products of the firm. Brand advertising provides an incentive for manufacturers to maintain product quality since they have invested a substantial amount in developing their image. Brand differentiation through advertising, therefore, may be of benefit to society to a certain extent as a form of information.

On the other hand, there are a number of wasteful and negative features of advertising. Advertising consumes a tremendous amount of resources in the economy as a whole, and a large portion appears to be unnecessary or cancelled-out by the advertising of rival firms. A large portion of advertising also appears to be persuasive in nature, with very little informational content. There is also an apparent relationship between advertising and market power, with explanations and casual factors occurring in both directions. Advertising intensity (advertising as a proportion of sales revenue) has been found to increase with concentration in most studies, although it appears to level off or even decline at very high concentration

levels. Advertising intensity reaches a maximum in oligopolistic industries, where research and advertising expenditures, rather than price, are the basis for competition between firms. In the reverse causal direction, it is argued that advertising can increase market power, allowing firms to charge higher prices than they could otherwise. Advertising also creates a barrier to entry by raising the costs of entry and the establishment of a market position for new or small firms. Finally, larger firms are believed to realize economies of scale in promotion, through quantity discounts from advertising media, and because advertising must reach a certain level of coverage before it is effective.

---

[1]For a discussion of both views of the issue of advertising, see F.M. Scherer, Industrial Market Structure and Economic Performance, Chicago: Rand McNally College Publishing Co., 1970, pp. 325-332; and K.B. Leffler, "Persuasion or Information? The Economics of Prescription Drug Advertising", Journal of Law and Economics, 24(1), April 1981, pp. 45-74.

ANNEX B
COMPULSORY LICENSING AND THE PHARMACEUTICAL INDUSTRY

A great deal of confusion and polemical debate has occurred over the revised compulsory licensing provisions in Section 41 of the Patent Act and their effect on the amount of research and development conducted by the pharmaceutical industry. The pharmaceutical industry has been used as an example, both by opponents of Plant Breeders' Rights legislation[1] and by those who support it[2] but fear that the licensing provisions could be too liberal, of the probable effects of breeders' rights legislation on structure and performance in the Canadian seed industry. These comparisons are incorrect on at least two counts: they draw inaccurate inferences on the effect of compulsory licensing on the amount of research and development performed by the pharmaceutical industry in Canada,[3] and they make an inappropriate comparison between two very dissimilar industries. The first of these is well discussed in the references cited below so this digression will deal only with the validity of a comparison between the two industries.

The two industries are different in a number of significant ways and their current industrial structures are different. The legislation proposed in Bill C-32 is quite different from the compulsory licensing provisions of the Patent Act which apply to pharmaceuticals. The effect of liberalizing compulsory licensing provisions for importation in the context of an existing patent system, for products of a concentrated industry consistently identified as one using the patent system to maintain artificially high prices and to price discriminate in Canadian markets, could be expected to be quite different from the effect of licensing provisions incorporated in a new system of property rights in a currently competitive industry. The initial reference points are quite dissimilar. The effect of the patent system on the level of research and development conducted by an

industry in a specific country depends significantly on the nature of the industry and the firms in it, their size, structure and ownership, and the existence of economies of scale in either research or production. The size, structure and ownership of the Canadian seed industry is presently quite different from that of the pharmaceutical industry. Foreign takeovers and domestic mergers could be handled under the Foreign Investment Review Act and under a strengthened Combines Investigation Act, if there were reasons to believe that mergers and increasing concentration would affect the innovative performance or potential of the Canadian seed industry.

---

[1]P.R. Mooney, Seeds of the Earth: A Private or Public Resource?, (Ottawa: Canadian Council for International Co-operation, 1979).

[2]Biotechnology: A Development Plan for Canada, Report of the Task Force on Biotechnology to the Minister of State for Science and Technology.

[3]Paul K. Gorecki, Regulating the Price of Prescription Drugs in Canada: Compulsory Licensing, Product Selection, and Government Reimbursement Programmes, Technical Report No. 8, Regulation Reference, Economic Council of Canada, May 1981, pp. 155-162; and Paul K. Gorecki and Ida Henderson, "Compulsory Patent Licensing of Drugs in Canada: A Comment on the Debate", Canadian Public Policy, 7:4, Autumn 1981, pp. 559-568. See also Peter Temin, "Technology, Regulation, and Market Structure in the Modern Pharmaceutical Industry", Bell Journal of Economics, 10:2, Autumn 1979, pp. 429-446 for a discussion of the relationship between patent regulation and health and safety regulation, and their effect on entry and research and development in the pharmaceutical industry. Drug health and safety regulations may play a role similar to the role played by the Seeds Act in restricting entry of new products.

POOR

QUALITY

ORIGINAL